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FINAL TIER II SAMPLING AND ANALYSIS PLAN PERFLUORINATED COMPOUNDS IN
GROUNDWATER AT THE FORMER NAS BRUNSWICK ME
10/09/2014
RESOLUTION CONSULTANTS

TIER II SAMPLING AND ANALYSIS PLAN
Perfluorinated Compounds in Groundwater
Former Naval Air Station (NAS) Brunswick
Brunswick, Maine

FINAL

Prepared for:



Department of the Navy
Naval Facilities Engineering Command, Mid-Atlantic
9742 Maryland Ave.
Norfolk, VA 23511-3095

Contract Number N62470-11-D-8013

CTO WE20

Prepared by:



Resolution Consultants
A Joint Venture of AECOM & EnSafe
1500 Wells Fargo Building
440 Monticello Avenue
Norfolk, VA 23510

October 9, 2014

SAP Worksheet #1: Title and Approval Page

FINAL

TIER II SAMPLING AND ANALYSIS PLAN

October 9, 2014

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CTO WE20

Review Signature:



10/9/14

Caryn DeJesus, CTO Manager
Resolution Consultants

Date

Approval Signature:

**SOLOMON.JUDITH.A.146
1885000**

Digitally signed by SOLOMON.JUDITH.A.1461885000
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ou=USN, cn=SOLOMON.JUDITH.A.1461885000
Date: 2014.10.09 16:13:22 -04'00'

Judith Solomon/Chemist, QA Manager
US Navy

Date

Other Approval Signature:

**BOBER.TODD.A.1228850
965**

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ou=USN, cn=BOBER.TODD.A.1228850965
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Todd Bober, Navy RPM
US Navy

Date

EXECUTIVE SUMMARY

This Sampling and Analysis Plan (SAP) has been prepared by Resolution Consultants (Resolution) for the U.S. Department of the Navy (Navy) and the Naval Facilities Engineering Command (NAVFAC). This SAP pertains to the monitoring well installation and sampling for two perfluorinated compounds (PFCs) in groundwater at the former Naval Air Station (NAS) Brunswick, Brunswick, Maine.

The two PFCs that will be evaluated in this SAP, perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), may indicate the presence of other PFCs. According to the United States Environmental Protection Agency (USEPA) Emerging Contaminant Fact Sheet on PFOS and PFOA (USEPA, 2013), these compounds are extremely persistent in the environment and resistant to typical environmental degradation processes. There are no toxicity values or water quality standards established for PFOS and PFOA, but in 2009, the USEPA developed short-term Preliminary Health Advisories (PHAs) for these two compounds to protect against potential risk from exposure to these chemicals through drinking water. Note that in March 2014 the Maine Center for Disease Control and Prevention (MECDC) established a Maximum Exposure Guideline (MEG) for PFOA.

Previous investigations for PFCs related to historic use of Aqueous Film Forming Foam (AFFF) at Site 11, the former Fire Training Area, included the investigation of PFOS and PFOA in groundwater in the vicinity of Site 11 and the Eastern Plume. The investigation included two rounds of sampling (conducted in August 2012 and May 2013) of eight monitoring wells, one extraction well and the influent and effluent of the Eastern Plume groundwater extraction treatment system (GWETS). Results of the investigation indicated that PFOS and/or PFOA were detected at all locations sampled during one or both of the sampling events. The highest concentrations of PFOA were detected above the USEPA PHAs at two wells in the northern half of the Eastern Plume (monitoring well MW-EP-347 [15 micrograms per liter (ug/L)] and extraction well EW-05B [9.1 ug/L]) and at Site 11 monitoring well MW-323 (7 ug/L), located upgradient of the Eastern Plume and immediately east of Site 11. Additional PFOA exceedances were observed at 3 other monitoring wells, the influent sample at the GWETS, and the effluent GWETS sample during the May 2013 sampling event. The locations with the highest concentrations of PFOS above the USEPA PHAs were at extraction well EW-05B (0.65 ug/L) and at Site 11 monitoring well MW-323 (1.2 J ug/L). Additional PFOS exceedances were observed at 3 other monitoring wells (three of which exceeded the USEPA PHAs in August 2012 but not in May 2013) and the influent sample at the GWETS. PFOA concentrations were generally higher than PFOS concentrations. (TetraTech, 2014)

A soil and groundwater investigation was performed in November and December 2012 for Buildings 611 and 555 to determine the presence of PFOS and PFOA due to a historic spill of AFFF at Building

555. Subsurface soil results indicate that PFOA was detected in two samples and PFOS was detected in three samples. All results were below the calculated soil screening level. Groundwater results indicate that PFOA was non-detect in three wells, detected at trace levels in six wells, and detected at a concentration of 0.1 ug/L in one well (MW-04S) which is below the USEPA PHA (0.4 ug/L) but at the same concentration as the MECDC MEG (0.1 ug/L). PFOS was non-detect in four wells, detected at trace levels in four other wells, and detected at concentrations above the USEPA PHA (0.2 ug/L) in wells MW-04S (0.3 ug/L) and MW-06S (0.36 ug/L). (TetraTech, 2013)

Based on the results of the previous investigations, further evaluation of the potential source areas was conducted to determine if additional investigation was warranted based on past operations. It was determined that additional groundwater assessment is warranted. The specific goals of this additional investigation (this SAP) are listed below and are further defined in this SAP:

- Goal 1 - Obtain a dataset that further evaluates the presence of PFOS and PFOA in potential source areas where AFFF was historically stored, used and/or released that may have impacted groundwater,
- Goal 2 - Determine background levels of PFOS and PFOA in groundwater in upgradient/non-site related areas, and
- Goal 3 - Obtain a dataset of 16 PFCs from the GWETS to determine its effectiveness on the treatment of various PFCs.

The data obtained from this investigation will supplement the previous PFC investigations. The data obtained from the separate, but concurrent groundwater investigation at the Eastern Flightline which includes sampling and analysis for PFOS and PFOA in the vicinity of potential source areas, will also supplement the basewide PFC evaluation.

The investigation objectives will be accomplished through the following:

- Installation of 17 monitoring wells in potential source areas.
- Collection and analysis of 32 groundwater samples in potential source areas (from 15 existing monitoring wells and 17 newly installed monitoring wells) for PFOS and PFOA.
- Collection and analysis of 4 groundwater samples from background monitoring wells for PFOS and PFOA.
- Collection and analysis of 4 groundwater samples from the GWETS (influent, high-pressure oxygen [HiPOx] system effluent, granular activated carbon [GAC] system mid-point, and effluent samples) for 16 PFCs.

An Investigation Summary Report will be prepared to document the results of the planned investigation. The report elements will include a summary of field efforts, deviations from the work plan (if any), data tables and figures, discussion of the analytical results, and all other Navy requirements for the report.

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Appendices

Appendix A Standard Operating Procedures

Appendix B TestAmerica ELAP Certification

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ACRONYMS AND ABBREVIATIONS

%R	Percent recovery
°C	Celsius
AFFF	Aqueous Film-Forming Foam
ARFF	Airport Rescue Fire-fighting
BRAC	Base Realignment and Closure
CAS	Chemical Abstracts Service
CHRIMP	Consolidated Hazardous Material Reutilization and Inventory Management Program
CLEAN	Comprehensive Long-term Environmental Action Navy
CNO	Chief of Naval Operations
CoC	Chain of Custody
CSM	Conceptual Site Model
CTO	Contract task order
DD	Day
DL	Detection limits
DO	Dissolved oxygen
DoD	Department of Defense
DoD QSM	Department of Defense Quality Systems Manual
DQI	Data quality indicator
DQO	Data quality objective
EC	Emerging Contaminant
EDD	Electronic Data Deliverable
ELAP	Environmental Laboratory Accreditation Program
FTL	Field Task Leader
FTMR	Field Task Modification Request
GAC	Granular Activated Carbon
GC	Gas chromatograph
GC/MS	Gas chromatography/mass spectrometry
GPS	Global positioning system
GWETS	Groundwater extraction treatment system
HDPE	High-density polyethylene
HiPOx	High-pressure Oxygen
IDW	investigative derived waste

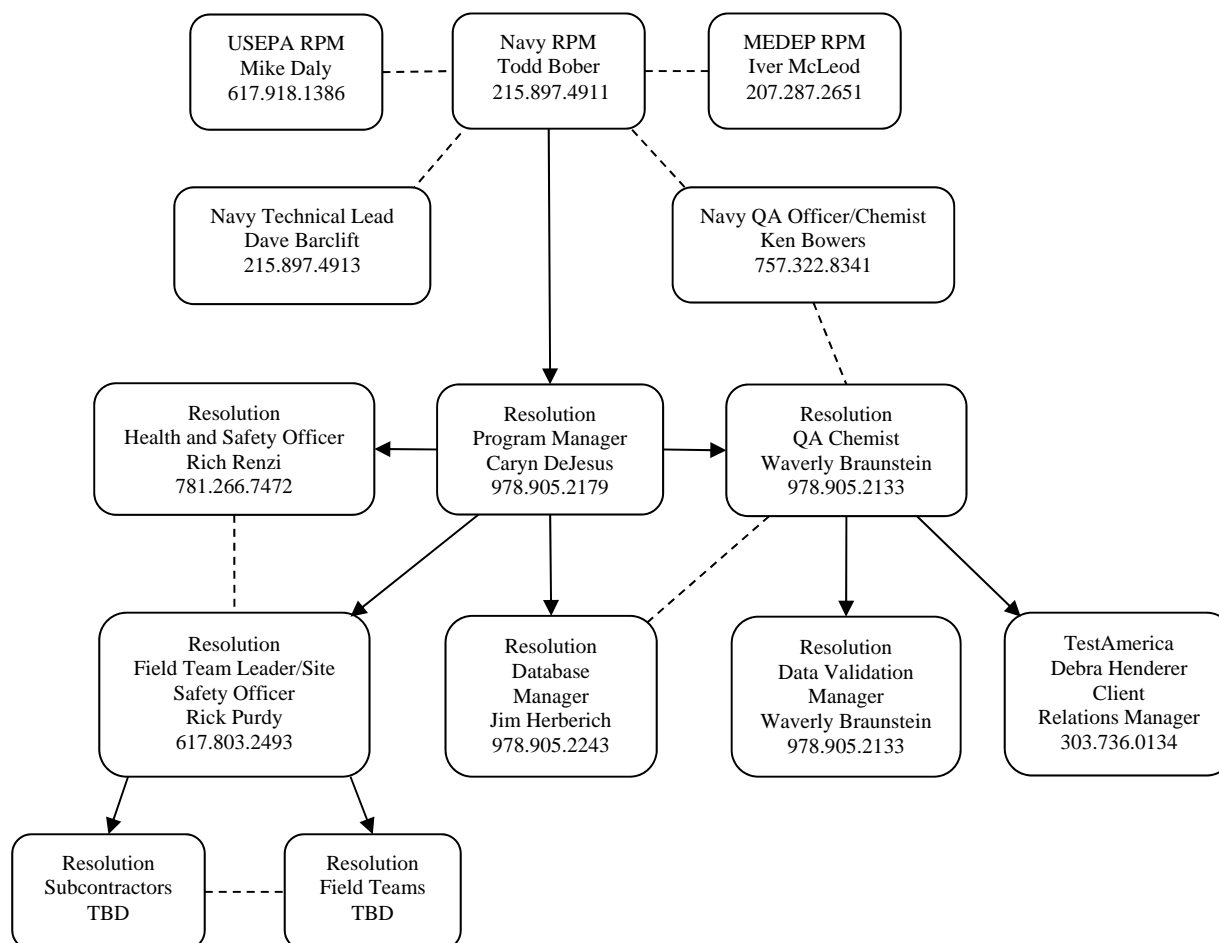
J	Data validation qualifier (estimated, detect)
L	Liter
LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate
LOD	Limit of detection
LOQ	Limits of quantitation
MECDC	Maine Center for Disease Control & Prevention
MEDEP	Maine Department of Environmental Protection
MEG	Maximum Exposure Guideline
MM	Month
MRRA	Midcoast Regional Redevelopment Authority
MS/MSD	Matrix spike/matrix spike duplicate
NA	Not applicable
NAS	Naval Air Station
NAVD	North American Vertical Datum
NAVFAC MIDLANT	Naval Facilities Engineering Command Mid-Atlantic
NEDD	Navy electronic data deliverable
NIRIS	Naval Installation Restoration Information Solution
NTU	Nephelometric Turbidity Units
OPR	Oxidation-reduction potential
OWS	Oil water separator
oz	Ounces
PDF	Portable Document Format
PFC	Perfluorinated Compound
PID	Photoionization detector
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonate
PM	Project manager
PMO	Project Management Office
PPE	Personal Protective Equipment
PQL	Project Quantitation Limit
PQO	Project quality objective
PSL	Project Screening Level
QA	Quality assurance

QA/QC	Quality assurance/quality control
QAPP	Quality assurance project plan
QC	Quality control
QSM	Quality systems manual
R	Data validation qualifier (rejected)
RPD	Relative percent difference
RPM	Remedial project manager
SAP	Sampling and Analysis Plan
SOP	Standard operating procedure
SSO	Site Safety Officer
TAT	Turnaround time
TBD	To be determined
µg/L	Micrograms per Liter
U	Data validation qualifier (non-detect)
UFP	Uniform Federal Policy
UFP-QAPP	Uniform Federal Policy for Quality Assurance Plans
UJ	Data validation qualifier (estimated, non-detect)
USEPA	U.S. Environmental Protection Agency
VOC	Volatile Organic Compounds
WFTA	West Fire Training Area
WWTP	Waste Water Treatment Plant
YYYY	Year

SAP Worksheet #5: Project Organizational Chart

[\(UFP-QAPP Manual Section 2.4.1\)](#)

Lines of Authority ——— Lines of Communication - - - - -



SAP Worksheet #6: Communication Pathways

[\(UFP-QAPP Manual Section 2.4.2\)](#)

The communication pathways for the Work Plan are shown below.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Regulatory Agency Interface	Base Realignment and Closure (BRAC) Program Management Office (PMO) Northeast Naval Facilities Engineering Command, Mid-Atlantic (NAVFAC MIDLANT)	Todd Bober	215.897.4911	Navy Remedial Program Manager (RPM) will interface with Regulatory Agency directly via phone or email as needed.
Field Progress Reports	Resolution	Caryn DeJesus	978.905.2179	The Resolution Field Team Leader (FTL) will email daily field progress reports to the Resolution Project Manager (PM). In addition, there will be phone conversation between the Resolution FTL and the Resolution PM as needed.
Stop Work due to Safety Issues	Resolution	Rick Purdy	617.803.2493	The Resolution Site Safety Officer (SSO) will verbally inform onsite personnel, including subcontractors as soon as possible. The Resolution SSO will verbally inform the Resolution PM of the Stop Work condition as well as when it is resolved. As need be, the Resolution SSO and/or PM will work with the Resolution Health & Safety Officer to resolve issues.
Work Plan Changes prior to Field/ Laboratory Work	Resolution	Caryn DeJesus	978.905.2179	The Resolution PM will notify the Navy RPM either verbally or via email of planned amendments to the Work Plan. The Resolution PM will document the changes via a Field Task Modification Request (FTMR) form and a concurrence letter.
Work Plan Changes in the Field	Resolution	Rick Purdy	617.803.2493	The Resolution Field Team Leader will verbally notify the Resolution PM as soon as practical of realizing a need for an amendment. The Resolution PM will notify the Navy RPM either verbally or via email the same day of the realized change and the changes will be documented in a scheduled impact letter to the Navy RPM.
Field Corrective Actions	Resolution	Rick Purdy	617.803.2493	The need for corrective action for field issues will be determined by the Resolution Field Team Leader. The Resolution Field Team Leader will notify the Resolution PM.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Sample Receipt Variances	Resolution	Waverly Braunstein	978.905.2133	The laboratory will notify the Resolution Project Chemist of issues with respect to sample receipt. The Resolution Project Chemist will notify the Resolution PM and/or Field Team Leader.
Notification of Non-Usable Data	TestAmerica	Debra Henderer	303.736.0134	<p>If the laboratory determines that any data they have generated is non-usable, the Laboratory PM will notify (verbally or via e-mail) the Resolution Project Chemist within 1 business day of when the issue is discovered.</p> <p>The Resolution Project Chemist will notify (verbally or via e-mail) the Resolution PM within 1 business day of the need for corrective action, if the non-usable data is a significant issue (i.e., critical sample data). Corrective action may include resampling and/or reanalyzing the affected samples.</p> <p>The Resolution Project Chemist will notify (verbally or via e-mail) Navy Project Chemist within 1 business day such that the Navy can determine if QA issues with the laboratory have the potential to impact other Navy projects.</p> <p>If the Resolution Project Chemist or data validator identifies non-usable data during the data validation process, the Resolution PM and Navy Project Chemist will be notified verbally or via e-mail within 48 hours of validation completion that a non-routine and significant laboratory quality deficiency has resulted in non-usable data.</p> <p>The Resolution PM will take corrective action appropriate for the identified deficiency to ensure the project objectives are met. The Resolution PM will notify (verbally or via e-mail) the Navy RPM of problems with the laboratory or analysis that could significantly affect the usability of the data or project failures that impact the ability to complete the scope of work. The Navy RPM, may at his discretion, contact the Navy Project Chemist for assistance in problem resolution. Such notification will be made within 1 business day of when the issue is discovered.</p>
Reporting Lab Quality Variances	Resolution	Waverly Braunstein	978.905.2133	The laboratory will notify the Resolution Project Chemist of issues in the analytical report case narrative.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Analytical Corrective Actions	Resolution	Waverly Braunstein	978.905.2133	The need for corrective action for analytical issues will be determined by the Resolution Project Chemist.
Laboratory Quality Issues	Resolution	Waverly Braunstein	978.905.2133	The Resolution Project Chemist will make the Resolution PM aware of laboratory quality issues. The Resolution PM will notify the Navy RPM if laboratory quality issues will significantly impact the project (i.e., significant meaning data is not useable or project schedule or costs have been majorly impacted). As appropriate, the Navy RPM will notify the Navy Chemist to ensure other Navy projects are not impacted.
Reporting Data Validation Issues	Resolution	Waverly Braunstein	978.905.2133	The Resolution Project Chemist will provide the Resolution PM with a report of issues affecting data quality as identified during the validation process. As necessary, the Resolution Project Chemist will notify the laboratory as soon as possible if issues are found with the data and work with the laboratory to resolve issues.
Data Validation Corrective Actions	Resolution	Waverly Braunstein	978.905.2133	The Resolution Project Chemist will notify the Resolution PM of actions that may be required as a result of the data validation.

SAP Worksheet #9-1: Project Scoping Session Participants Sheet

[\(UFP-QAPP Manual Section 2.5.1\)](#)

Project Name:	Groundwater Perfluorinated Compound Investigation		Site Name:	NAS Brunswick	
Projected Date(s) of Sampling:	Spring 2014		Site Location:	Brunswick, Maine	
Project Manager:	Caryn DeJesus				
Date of Session:	January 22, 2014, follow up information dated January 27, 2014				
Scoping Session Purpose:	Discuss Project Goals and Potential AFFF Areas				
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Todd Bober	BRAC RPM	BRAC PMO Northeast NAVFAC MIDLANT	215.897.4911	Todd.Bober@navy.mil	Project Management
Dave Barclift	Navy Risk Assessor	BRAC PMO Northeast NAVFAC MIDLANT	215.897.4913	David.Barclift@navy.mil	Risk Assessor
Paul Burgio	BRAC Environmental Coordinator	BRAC PMO Northeast NAVFAC HQ	215.897.4903	Paul.Burgio@navy.mil	BRAC Environmental Coordinator
Bob LeClerc	Site Caretaker	NAS Brunswick Caretaker Site Office	207.406.2290	Robert.LeClerc@navy.mil	Site Caretaker
Caryn DeJesus	CTO Manager	Resolution	978.905.2179	Caryn.DeJesus@aecom.com	Project Management
Elizabeth Perry	Senior Hydrogeologist	Resolution	978.905.2359	Elizabeth.Perry@aecom.com	Technical Lead
Jeff Orient	CTO Manager	TetraTech	--	Jeff.Orient@tetrattech.com	Project Management
Ralinda Miller	Technical Lead	TetraTech	--	Ralinda.Miller@tetrattech.com	Technical Lead

Comments/Decisions:

- Discussed project goal to evaluate PFCs in groundwater based on operations that may have had associated releases of AFFF. To date, TetraTech has performed two rounds of limited groundwater sampling for PFOS/PFOA in the vicinity of the Eastern Plume and

Site 11, the former Fire Training Area. This evaluation would collect data from other areas at the former NAS Brunswick base to assess potential source areas (associated with storage, use and/or known releases) of AFFF.

- Discussed that the investigation is not under regulatory authority, but that the Navy is conducting the investigation to evaluate PFOS/PFOA as emerging contaminants since AFFF has been used at the former NAS Brunswick base.
- Discussed the following locations as being areas where AFFF has been stored, used and/or had a known release:
 - Site 11 – Former Fire Training Area
 - Eastern Plume (Result of Sites 4, 11 and 13)
 - Hangar 5
 - Hangar 6
 - West Fire Training Area
- Discussed that the likely AFFF source areas are Site 11, Eastern Plume and Hangar 5 based on past storage, use and known releases of AFFF.
- Discussed that Hangar 6 has had no releases, therefore, this area is not considered a potential source area for AFFF.
- Discussed that a previous investigation at the West Fire Training Area indicated that several wells proposed to be installed could not be installed due to the area being underlain by clay and that little groundwater was found. Only 1 or 2 samples were collected and no target compounds were identified. TetraTech indicated that there was no documented use of AFFF for the West Fire Training Area, and that this area is not considered a potential source area for AFFF.
- Discussed that additional wells are likely needed to evaluate areas that may have been impacted by releases of AFFF, in particular, the flight line due to the use/release of AFFF in a cockpit fire incident in 1998. TetraTech suggested that wells may be necessary along the eastern side of the flight line.
- Discussed that the PFC data will likely be used to update current and future Land Use Control documents (if necessary). Because of this, the focus for the Eastern Plume area should be on wells that are along the edge of the currently-defined plume rather than inside the plume area. The area inside the currently-defined plume is already targeted for land-use controls.

-
- Discussed that the monitoring at the current groundwater extraction treatment system includes influent and effluent samples for PFOS/PFOA.
 - Additional information provided by TetraTech via email on January 27, 2014 included additional buildings and a Tier II Reporting list of AFFF storage/use for the following areas:
 - Hangar 4
 - Hangar 5
 - Hangar 6
 - Building 51
 - Building 81
 - Building 292
 - Building 294
 - Building 555
 - Building 611
 - Building 653
 - Based on the additional information provided, each building will be evaluated for the storage, use and/or known releases of AFFF to determine if sampling should be proposed in these areas.

Action Items:

- Evaluate areas identified as AFFF source areas and determine if groundwater sampling in the vicinity of each area is warranted.
- Develop Tier II SAP for proposed PFC Investigation.

Consensus Decisions:

- Plan for a field program to be conducted in Spring 2014.

SAP Worksheet #9-2: Project Scoping Session Participants Sheet

[\(UFP-QAPP Manual Section 2.5.1\)](#)

Project Name:	Groundwater Perfluorinated Compound Investigation	Site Name:	NAS Brunswick		
Projected Date(s) of Sampling:	Late Summer/Early Fall 2014	Site Location:	Brunswick, Maine		
Project Manager:	Caryn DeJesus				
Date of Session:	May 21, 2014				
Scoping Session Purpose:	Preliminary Discussion of the Draft PFCs in Groundwater SAP				
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Todd Bober	BRAC RPM	BRAC PMO Northeast NAVFAC MIDLANT	215.897.4911	Todd.Bober@navy.mil	Project Management
Paul Burgio	BRAC Environmental Coordinator	BRAC PMO Northeast NAVFAC HQ	215.897.4903	Paul.Burgio@navy.mil	BRAC Environmental Coordinator
Bob LeClerc	Site Caretaker	NAS Brunswick Caretaker Site Office	207.406.2290	Robert.LeClerc@navy.mil	Site Caretaker
Caryn DeJesus	CTO Manager	Resolution	978.905.2179	Caryn.DeJesus@aeacom.com	Project Management
Chris Evans	Project Manager	MEDEP	207.441.5181	Gordon.C.Evans@maine.gov	Project Manager
Iver McLeod	Program Director	MEDEP	207.287.2651	Iver.McLeod@maine.gov	Program Management
Mike Daly	Project Manager	EPA	617.918.1386	Daly.Mike@epa.gov	Project Management

Comments/Decisions:

- Resolution Consultants provided a summary of the proposed PFCs sampling program for potential AFFF source areas as provided in the Draft PFCs in Groundwater SAP submitted to the agencies on May 12, 2014. Resolution indicated that following the submittal of the Draft SAP, additional PFC data collected in late 2012 as part of an investigation at Buildings 611/555 were made available. Review of the data would impact the proposed sampling program; therefore, the Draft SAP would be updated to include this additional data.

- Discussed the ubiquitous nature of PFCs and EPA's primary concern being potential receptors, including the two water bodies, as well as the bioaccumulative nature of PFCs in benthic environments.
- MEDEP inquired about the decommissioning process for fire suppression systems and tanks containing AFFF. Bob Leclerc indicated that the majority of those systems are still in place, in particular for buildings (e.g., hangar buildings) that were transferred to Midcoast Regional Redevelopment Authority (MRRA). These systems and contents were useful for MRRA for the property transfer. Bob discussed that some of the spills with AFFF often led to oil water separators (OWS) as well as the former NAS Brunswick sanitary sewer system. The OWS for the former NAS Brunswick have all since been cleaned out. Historic discharge of AFFF into the sanitary sewer system led to issues with the local waste water treatment plant (WWTP).
- Bob Leclerc indicated that at some point (at least 11 years prior) a shack was constructed on Admiral Fitch Avenue near the entrance to NASB where a neutralizing chemical was injected to the sanitary system prior to the discharge to the local WWTP.
- EPA inquired about the review process for identifying the potential source areas. Resolution indicated that the process included evaluating the obvious areas (AFFF storage tanks, fire areas, etc.), information from the MEDEP Spills Database, the NASB Incident Log, etc. The information for all areas reviewed was summarized, including references, in a table in the proposed SAP.
- Also discussed were any fire events, in which only one was identified in 1998 where the discharge was to Picnic Pond.

Action Items:

- MEDEP will review Draft SAP and submit comments.
- EPA would likely not review the Draft SAP until the end of the summer.
- Resolution will revise the Draft SAP to include additional PFC data from the Building 611/555 investigation.

Consensus Decisions:

- Update SAP based on new data and information not previously included in the SAP.
- Plan for a field program to be conducted in late summer/early fall 2014.

SAP Worksheet #9-3: Project Scoping Session Participants Sheet

[\(UFP-QAPP Manual Section 2.5.1\)](#)

Project Name:	Groundwater Perfluorinated Compound Investigation	Site Name:	NAS Brunswick		
Projected Date(s) of Sampling:	Late Summer/Early Fall 2014	Site Location:	Brunswick, Maine		
Project Manager:	Caryn DeJesus				
Date of Session:	June 24, 2014				
Scoping Session Purpose:	Follow-up Discussion of the Draft PFCs in Groundwater SAP				
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Todd Bober	BRAC RPM	BRAC PMO Northeast NAVFAC MIDLANT	215.897.4911	Todd.Bober@navy.mil	Project Management
Dave Barclift	Navy Risk Assessor	BRAC PMO Northeast NAVFAC MIDLANT	215.897.4913	David.Barclift@navy.mil	Risk Assessor
Paul Burgio	BRAC Environmental Coordinator	BRAC PMO Northeast NAVFAC HQ	215.897.4903	Paul.Burgio@navy.mil	BRAC Environmental Coordinator
Bob LeClerc	Site Caretaker	NAS Brunswick Caretaker Site Office	207.406.2290	Robert.LeClerc@navy.mil	Site Caretaker
Caryn DeJesus	CTO Manager	Resolution	978.905.2179	Caryn.DeJesus@aecom.com	Project Management
Chris Evans	Project Manager	MEDEP	207.441.5181	Gordon.C.Evans@maine.gov	Project Manager
Iver McLeod	Program Director	MEDEP	207.287.2651	Iver.McLeod@maine.gov	Program Management
Mike Daly	Project Manager	EPA	617.918.1386	Daly.Mike@epa.gov	Project Management

Comments/Decisions:

- Discussed the status of the Draft PFCs in Groundwater SAP, and inquired with MEDEP and EPA if they had any questions regarding the SAP. MEDEP indicated that they had reviewed the document and submitted comments on June 19, 2014. EPA indicated that the

report had not yet been reviewed, but based on recent experience with PFCs at another site, that further information on the use of AFFF should be investigated. The following comments were noted:

- Confirm the storage and use of AFFF at locations such as hangars and the fire department, including fire trucks. Confirm how the fire trucks were filled up.
- Confirm fire training areas, in particular the training area north of Hangar 6 to identify where the discharge would go.
- Include proposed location in the Site 1 & 3 area as the soils removed from remediation of Site 11 - the former Fire Training Area (FTA) were disposed of at this landfill area.
- Conduct interviews with former staff/fire department to identify additional information on the storage, use, and maintenance and operation activities associated with AFFF.
- Resolution indicated that a site visit would be conducted to review site files for additional details on historic use and releases of AFFF.

Action Items:

- Conduct a site visit to review site files that may pertain to PFCs.
- Contact/interview former Navy staff (e.g., fire chief) to obtain details on historic AFFF use and practices associated with the former fire department.
- Update SAP based on new data and information not previously included in the SAP.

Consensus Decisions:

- Update and re-submit revised Draft SAP based on new data and information not previously included in the Draft SAP.
- Plan for a field program to be conducted in late summer/early fall 2014.

SAP Worksheet #10: Conceptual Site Model

[\(UFP-QAPP Manual Section 2.5.2\)](#)

10.1 Background Study Goals and Objectives

This study at the former NAS Brunswick base is being performed to obtain data on the potential presence of two PFCs (PFOS and PFOA) in groundwater at potential source areas where AFFF was historically stored, used and most likely to have been released. A background dataset for PFOS and PFOA will also be obtained in upgradient/non-site related areas to distinguish concentrations that may be due to Navy activities from concentrations that may represent widespread, ubiquitous anthropogenic PFOS and PFOA in groundwater.

The two PFCs that will be evaluated in this SAP, PFOS and PFOA, may indicate the presence of other PFCs. According to the USEPA Emerging Contaminant Fact Sheet on PFOS and PFOA (USEPA, 2013), these compounds are extremely persistent in the environment and resistant to typical environmental degradation processes. There are no toxicity values or water quality standards established for PFOS and PFOA, but in 2009, the USEPA developed short-term PHAs for these two compounds to protect against potential risk from exposure to these chemicals through drinking water. Note that in March 2014 the Maine Center for Disease Control and Prevention (MECDC) established a Maximum Exposure Guideline (MEG) for PFOA.

The use of AFFF has been documented in reports for various locations (e.g., buildings) at the former NAS Brunswick base. **Table 10-1** provides a summary of locations where AFFF has historically been stored, used and/or had a release. Based on the review of documented information, each location was evaluated to determine if additional investigation was warranted.

The objective of this investigation is to obtain a dataset to assess the presence of PFOS and PFOA in groundwater in potential source areas at the former NAS Brunswick base where AFFF was most likely to have been released to the environment as well as to obtain background levels of PFOS and PFOA in groundwater. The data obtained from this investigation will supplement the previous PFC investigation conducted at Site 11 and the Eastern Plume.

As indicated in the Navy's policy (Chief of Naval Operations [CNO], 2004), the use of background chemical levels is to distinguish between evidence of release or disposal of hazardous substances in excess of reportable quantities caused by the Navy (a site release) and basewide background chemical levels (naturally occurring and anthropogenic). The Navy's policy requires basewide background levels in non-site areas to be established to ensure that cleanup levels for sites (spills, releases, disposal areas) are not less than background concentrations (both naturally occurring and anthropogenic).

This SAP details the overall approach and the activities planned for this investigation. **Figure 10-1** presents a general location map for the potential source areas.

10.2 Brief Operational History of NAS Brunswick

NAS Brunswick was officially closed on September 15, 2011 under the Base Realignment and Closure Act (BRAC) program. The property is currently in “caretaker” site status overseen by the Naval Facilities Engineering Command (NAVFAC). NAS Brunswick was originally constructed and occupied in March 1943 with the primary mission of training British Naval Command (Royal Canadian Air Force) pilots. It was deactivated in October 1946, and between 1947 and 1951, the land and buildings were leased for various non-military activities. On March 15, 1951, the dormant air station was re-commissioned as a Naval Air Facility with the established mission of supporting three land-plane patrol squadrons and one Fleet Aircraft Service Squadron, and a planned future mission as a master jet air station with a primary mission of anti-submarine warfare. During the 1950s, the installation underwent a period of expansion and construction including expansion of runways, hangars and housing. In December 1951 the Naval Air Facility was officially changed to the designation of Naval Air Station (NAVFAC-Midlant, 2006a; BRAC PMO, 2010; Malcolm Pirnie, Inc., 2006). In 1971, Commander Patrol Wings United States Atlantic Fleet/Commander Patrol Wing Five established its headquarters at NAS Brunswick. Since 1971, changes occurred at NAS Brunswick, including the addition of three patrol squadrons flying the P3 Orion, two reserve squadrons, VPU-1 mission, the Naval Reserve Center, the Air Reserve Center, as well as providing support for ships at Bath and other various northeastern naval activities (NAVFAC-Midlant, 2006b).

10.3 Previous Investigations

Two separate investigations conducted at the former NAS Brunswick base have included sampling for PFCs. Details of each investigation are provided below.

10.3.1 Site 11 and Eastern Plume PFC Investigation

An initial investigation for PFCs related to AFFF included the evaluation of PFOS and PFOA in groundwater in the vicinity of Site 11, the former Fire Training Area and the Eastern Plume. The objective of the investigation, as documented in the January 30, 2014 *Technical Memorandum, Perfluorinated Compounds in Groundwater, Site 11 and The Eastern Plume*, was to determine if PFCs were present in groundwater at Site 11 and/or the Eastern Plume based on historic use of AFFF at Site 11. Because of its use as a fire training area, Site 11 was believed to be the location where PFCs were most likely to have been released. The investigation included two rounds of sampling (conducted in August 2012 and May 2013) of eight monitoring wells, one extraction well and the influent and effluent of the Eastern Plume GWETS. Samples were analyzed for PFOS and PFOA.

Results of the investigation are presented on **Figure 10-2** and indicate that PFOS and/or PFOA were detected at all locations sampled during one or both of the sampling events. The highest concentrations of PFOA were detected above the USEPA PHAs at two wells in the northern half of the Eastern Plume (monitoring well MW-EP-347 [15 ug/L] and extraction well EW-05B [9.1 ug/L]) and at Site 11 monitoring well MW-323 (7 ug/L), located upgradient of the Eastern Plume and immediately east of Site 11. Additional PFOA exceedances were observed at 3 other monitoring wells, the influent sample at the GWETS, and the effluent GWETS sample during the May 2013 sampling event. The locations with the highest concentrations of PFOS above the USEPA PHAs were at extraction well EW-05B (0.65 ug/L) and at Site 11 monitoring well MW-323 (1.2 J ug/L). Additional PFOS exceedances were observed at 3 other monitoring wells (three of which exceeded the USEPA PHAs in August 2012 but not in May 2013) and the influent sample at the GWETS. PFOA concentrations were generally higher than PFOS concentrations. (TetraTech, 2014)

10.3.2 Building 611/555 Investigation

A soil and groundwater investigation was performed in November and December 2012 for Buildings 611 and 555 to evaluate whether soil and groundwater contamination was present based on past operations of the two buildings. Buildings 611, the Aircraft Intermediate Maintenance Department (AIMD) Engine Test Cell, is located near the end of the aircraft apron south of Hangar 5. Building 555, the Sonobuoy/Vehicle Storage Building, is directly east of Building 611 (refer to **Figure 10-1**). Due to a historic spill of AFFF at Building 555 (refer to **Table 10-1**), the presence of PFOS and PFOA were evaluated in soil and groundwater.

Subsurface soil results indicate that PFOA was detected in two samples and PFOS was detected in three samples. All results were below the calculated soil screening level. Groundwater results indicate that PFOA was non-detect in three wells, detected at trace levels in six wells, and detected at a concentration of 0.1 micrograms per liter (ug/L) in one well (MW-04S) which is below the USEPA PHA (0.4 ug/L) but at the same concentration as the MECDC MEG (0.1 ug/L). PFOS was non-detect in four wells, detected at trace levels in four other wells, and detected at concentrations above the USEPA PHA (0.2 ug/L) in wells MW-04S (0.3 ug/L) and MW-06S (0.36 ug/L). Results of the groundwater investigation are presented on **Figure 10-3**. (TetraTech, 2013)

10.4 Historic AFFF Site Operations

A review of historic site operations was conducted to further identify areas where AFFF was stored, used, and where accidental releases/spills may have occurred. This included a review of site records, interviews with former staff and visual identification (e.g., location of ASTs, fire suppression systems, etc.). Based on the review, the use of AFFF at the former NAS Brunswick base was related to fire operations and activities. The sections below summarize the available

information on the historic use of AFFF and potential impacts it may have on the environment. Pertinent site features related to the historic use of AFFF are shown on **Figure 10-4**.

10.4.1 Building 292, Fire Department

Building 292 was constructed in 1957 as the fire department building for the former NAS Brunswick base. Building 292 functioned solely as a fire station until the base closure on September 15, 2011. Fire-fighting operations at the former NAS Brunswick base did not initially use AFFF. The use of AFFF was phased in sometime in the late 1970s through the early 1980s. According to the former program manager for fire and emergency services, a protein based fire foam was used prior to transitioning to the use of AFFF. After the shutdown of the airport as part of the former NAS Brunswick base operations in January 2010, the use of AFFF ceased.

During the fire operations when AFFF was used, the fire station housed three aircraft rescue and fire-fighting (ARFF) vehicles and two structural apparatus vehicles, each of which contained a tank to store AFFF. The ARFF vehicles each contained an AFFF storage tank ranging from 100 to 160 gallons and the two structural apparatus vehicles each contained an AFFF storage tank ranging from 50 to 60 gallons. Note that the range in tank size is based on the change in fire vehicles over the years. The tanks contained AFFF concentrate which could be mixed with water by means of mechanical switch operations on the fire vehicle itself. The AFFF tanks were manually filled primarily from 5-gallon buckets. Occasionally, but not a common practice, the tanks would be filled via pumping from a 55-gallon drum containing the AFFF. See Section 10.4.2 below regarding the storage of AFFF on the former NAS Brunswick base.

Fire truck operations included a daily check of each of the fire trucks. Each truck would be inspected on the ramp area just outside of Building 292 (east of the runway) and included a water discharge for approximately 3 seconds through the hose turret to ensure proper function of the hose/water operation. According to the former deputy fire chief, approximately two to three times a year the switch for AFFF would accidentally be turned on during the daily check and AFFF would be mixed with the water discharge. In such instances, the truck would be flushed with approximately 3,000 gallons of water to clear out the hose line and dilute the foam discharge. The water was discharged to the area where the daily water check was dispensed, which was located in the grassy area west of the Building 292 ramp, and east of the runway (see **Figure 10-4**).

Additional truck maintenance included fully dispensing the contents of the AFFF tanks for each fire vehicle on a quarterly basis. However, the frequency was often less due to inadvertently missing the dispensing cycle, and was more on the order of two to three times a year. The dispensing process including mixing AFFF with water during the dispensing and continued until the contents of the tank were empty. This would use approximately 3,000 to 5,000 gallons of water to empty the contents of each of the AFFF tanks. The dispensing locations were selected by the Environmental

Department, and were frequently one of six common locations. These locations are presented on **Figure 10-4** and included:

1. The grassy area west of Taxiway Alpha, west of Building 292;
2. Wooded area south of Hangar 5 or in snow banks in this area during winter months;
3. The grassy area east of Hangar 5 and east of Taxiway Alpha;
4. The grassy area behind a house along perimeter road (which has since been demolished);
5. The grassy area west of Admiral Fitch Avenue near the main entrance to the former NAS Brunswick base; and
6. The grassy/wooded area past the paved area at the Red Label Area.

Fire vehicles were washed on a daily basis and as needed when the vehicles were dirty. While the washing did not include the use of AFFF, the potential for AFFF residual may be present, for example, from tank filling operations. The fire vehicles were washed either outside on the ramp where discharge went to the grassy area and nearby stormwater drains or inside where discharge was to the floor drains. A 400-gallon oil water (O/W) separator was located in the northeast portion of the apparatus bay area and collected discharge from the floor drains from the apparatus bays (and mechanical rooms) prior to discharge to the sanitary sewer. The O/W separator was serviced annually as part of the basewide O/W separator and trench drain maintenance program. After Building 292 was vacated, the O/W separator was last cleaned on October 25, 2011. The annual service included removal of accumulated petroleum products and excessive sludge and proper disposal of the collected petroleum-contaminated water, petroleum products and sludge. The water and sludge was disposed of as non-hazardous, oil-contaminated liquid and solids. (TetraTech, 2011a; 2011b)

Small mechanical repairs to fire trucks may have been conducted at Building 292; however, heavy mechanical repairs were conducted at one of the Transportation/Maintenance Buildings (Buildings 225, 252 or 590). One accidental release of AFFF associated with maintenance of one of the ARFF vehicles was reported at Building 252, the Public Works Vehicle Maintenance Shop. Refer to **Table 10-1** regarding the details of the release. Any mechanical repair operations related to the fire apparatus function required the truck to be sent to a facility outside of the former NAS Brunswick base.

10.4.2 AFFF Storage

As discussed above, the fire vehicles associated with fire operations required storage of AFFF. As part of the fire operations, a replacement load of AFFF was required to be immediately available. This included the storage of half of the total volume of the five fire vehicles (three ARFF vehicles and two structural apparatus vehicles) to be stored at Building 292, the Fire Department building. According to the former deputy fire chief, half of the total volume of the tanks was approximately 345 gallons. This volume was stored in 5-gallon buckets in the back hallway of Building 292. In addition, twice the total tank volume was required to be in storage as a backup measure. According to the former deputy fire chief, this was approximately 1,500 gallons which was stored in 5-gallon buckets. Storage of the AFFF was at various buildings throughout the years and included the following buildings:

- Building 51, Naval Criminal Investigation Services (NCIS)/Fire Prevention Building;
- Building 81, Consolidated Hazardous Material Reutilization and Inventory Management Program (CHRIMP);
- Building 294, Supply Warehouse; and
- Building 555, Sonobuoy/Vehicle Storage.

The former deputy fire chief did not recall any accidental spills or releases related to the storage of AFFF. However, a single release of 40 gallons of AFFF was noted within Building 555 and likely discharged to the sanitary sewer (refer to **Table 10-1**).

10.4.3 Fire Training Areas

Three fire training areas have historically been used at the former NAS Brunswick base and included:

- Site 11, the former Fire Training Area;
- West Fire Training Area (WFTA); and
- the Fire Training Area north of Hangar 6.

The approximate locations of these former training areas are shown on **Figure 10-4**.

The primary fire training area used at the former NAS Brunswick base was Site 11, the former Fire Training Area. Site 11 is located on the north side of Purinton Road, southeast of Building 50, the GWETS building (refer to **Figure 10-4**). The former Fire Training Area was used regularly from the 1950s until the fall of 1990 to train Navy personnel firefighting techniques. Until 1987, fire training exercises including placing waste liquids (e.g., fuels, oils, and degreasing solvents) onto the

ground surface where they were ignited and fire training activities occurred. In 1987, a circular concrete liner, berm and 6,000 gallon UST was installed at the site. The concrete pad and UST were later removed in 1995. (ECC and EA, 2005) According to the former deputy fire chief, the fire training activities included the use of AFFF.

The WFTA is located approximately 300 feet west of the runway (refer to **Figure 10-4**). Waste solvents and fuels were historically placed in a steel tank (estimated to be 100 gallons) that was attached to a trailer. After the tank was filled, it was transported to a concrete pad (known as the WFTA) where the waste liquid was ignited and the response time determined for the former NAS Brunswick fire department to extinguish the fire (TetraTech, 2010). According to the former deputy fire chief and the former program manager for fire and emergency services, the WFTA appears to have been used prior to when the former NAS Brunswick base used AFFF.

A third Fire Training Area was located north of the Hangar 6 parcel parking area, on the abandoned runway (refer to **Figure 10-4**). A stainless-steel aircraft mock-up containing propane jets were ignited for fire-fighting training activities. The mock aircraft and propane tanks were later removed. No liquid petroleum fuel was used during the fire-training activities. No reported impacts from the fire-training activities were reported. According to the former deputy fire chief, only water was used to extinguish the fires (i.e., AFFF was not used).

10.4.4 Fire Suppression Systems

Fire suppression systems were located at various buildings at the former NAS Brunswick base and were either water- or foam-based (i.e., AFFF) systems. Foam-based fire suppression systems were located at the following buildings:

- Building 81, CHRIMP
- Building 653, Foam House
- Hangars 4, 5 and 6

Note that the fire suppression system in Building 81 was removed prior to the lease of the property. Building 653, Hangar 5 and Hangar 6 still contain AFFF fire suppression systems; however, these properties have been transferred. Hangar 4 is currently under lease which includes the AFFF fire suppression system. Therefore, the Navy no longer owns the AFFF fire suppression systems in Hangars 5 and 6, nor does the Navy maintain the AFFF fire suppression system in Hangar 4.

When the base was operational, accidental releases from the AFFF fire suppression systems occurred. According to the former deputy fire chief, approximately two to three accidental releases from each building's AFFF fire suppression system occurred. Causes of the accidental releases from

the fire suppression systems were triggered by various methods, such as a lightning strike (Building 653), motion of a computer screen saver (Hangar 4), and inadvertently leaving the AFFF valve open during fire suppression system testing (Hangar 5). Refer to **Table 10-1** for details of accidental releases from the AFFF fire suppression systems.

As mentioned above, the fire suppressions systems were tested periodically. During the testing of the systems, the valve for the AFFF release mechanism was shut from the ASTs in which the AFFF was stored. Generally, there were two separate ASTs that stored AFFF, a primary tank and a secondary backup tank. During the testing the valves would be checked that the mechanical operation was functioning, although no AFFF was released. However, in at least one incident, the AFFF valve was not shut off and a release occurred during testing of the fire suppression system in Hangar 5 (refer to **Table 10-1**).

10.4.5 Neutralization Shack

Due to the number of accidental discharges of AFFF to sanitary sewer, treatment of the sanitary drain line was implemented by the Navy as a corrective measure prior to discharge from the former NAS Brunswick base. Although the date of installation is unknown, a shack was constructed prior to 1997 on Admiral Fitch Avenue near the entrance to NASB where a defoaming chemical was injected into the sanitary sewer system prior to discharge to the local WWTP (the Brunswick Sewer District). The approximate location of the shack is shown on **Figure 10-4**. According to the former deputy fire chief, when an accidental discharge of AFFF to the sanitary system occurred (e.g., from a fire suppression system), someone from the fire department or the environmental department would be sent to the "neutralization shack" to turn on a pump to inject a chemical to "neutralize" the foaming action of the AFFF. Based on a site visit to the neutralization shack on June 3, 2014, paperwork within the shack indicated that the neutralization chemical used was Defoamer DFG10 by ChemQuest, Inc. While the defoamer would reduce the amount of foam that would enter into the WWTP; in a letter from the Brunswick Sewer District to the Navy regarding an accidental release of AFFF on October 25, 2002 from the fire suppression system at Hangar 5, there was concern that the defoamer breaks down the foam, but does not break down the chemical compound that produces the foam. It was also noted that although the amount of foam was reduced prior to entering the WWTP, the foam was re-activated by the agitation processes of the pumping station within the WWTP. The Brunswick Sewer District would also add a defoaming agent to their system if foam levels increased as part of the WWTP processes occurred.

Currently, the neutralization shack remains in place, although it is no longer used by the Navy since the transfer of Building 81, Building 653, Hangars 5 and 6, the lease of Hangar 4 and the shutdown of the airport operations in January 2010, when the use of AFFF for fire operations ceased.

10.4.6 Fires

Historically, two fires occurred at the former NAS Brunswick base. The first fire occurred on April 28, 1998 when a cockpit of an airplane on the tarmac caught on fire. According to MEDEP Spill Report #P-198-1998, 110 gallons of AFFF diluted in 3,000 gallons of water was used and discharged to the stormwater drainage system. The stormwater drainage system is the former Picnic Pond Stormwater Retention System, which is the subject of a separate investigation. That investigation includes sampling of PFOS and PFOA in surface water and sediment sample locations.

The second fire occurred on June 13, 2007 at Hangar 1 when the hangar was being demolished. According to the former deputy fire chief and the former program manager for fire and emergency services, this fire was extinguished with water only (i.e., AFFF was not used).

10.4.7 Fuel Spills

Although it was a fairly common practice to apply AFFF on fuel spills along tarmacs to prevent ignition and to suppress flammable vapors, according to the former deputy fire chief this practice was not conducted at the former NAS Brunswick base. Instead, runway maps were used to identify where runoff/drainage from ramps were directed. Preventative measures were conducted at the drainage areas to prevent spills from leaving the former NAS Brunswick base.

10.4.8 Environmental Remediation Operations

Remediation activities at Site 11, the former Fire Training Area, included the removal of soils which were disposed of at the Sites 1 and 3 landfill. As Site 11 was formerly used as a fire training area in which AFFF was used, the soils within Sites 1 and 3 may contain PFCs.

10.5 General Conceptual Site Model

This conceptual site model (CSM) has been developed for the investigation of PFCs in groundwater associated with the historic use and releases of AFFF from past operations at the former NAS Brunswick base. The information below presents the potential contaminant release mechanisms, contaminant migration, the nature and extent of PFCs associated with the historic use and releases of AFFF and routes of exposure to potential receptors.

10.5.1 Contaminant Release Mechanisms

Historic operations at the former NAS Brunswick base indicate the use, storage and/or release of AFFF throughout its operational history. While AFFF could be accidentally released from storage areas or AFFF fire suppression systems, it is also intentionally released when used to aid in fire-fighting, fire-fighting training activities, and fire vehicle operation and maintenance activities. As presented in **Table 10-1**, various locations (e.g. buildings, etc.) have either stored and/or had a release of AFFF.

The majority of the releases occurred due to accidental discharges from the AFFF fire suppression systems. Several of the reported releases, as detailed on **Table 10-1**, were quite significant and discharge of AFFF was to storm drains or the sanitary sewer, and in some instances to the former Picnic Pond stormwater retention pond system. As mentioned above, the former deputy fire chief indicated that each of the buildings that contained AFFF fire suppression systems likely had two to three accidental releases, most of which were significant as the systems are designed as full flooding systems.

Small spills of AFFF were also reported (e.g., Building 252 and Building 653), and discharge was likely to the sanitary sewer system.

Only one fire was reported to have used AFFF to suppress the fire, and discharge was to the former Picnic Pond stormwater retention system.

AFFF was also used for fire training purposes for a 30 year period ending in 1990 at Site 11, the former Fire Training Area.

Other operations that would release AFFF included operation and maintenance of fire vehicles. Approximately two to three times a year there would be an accidental release of AFFF during the daily checks on the fire vehicles. In addition, two to three times a year, the contents of the AFFF tanks on the fire vehicles would be fully discharged via mixing with water at various locations on the former NAS Brunswick base.

10.5.2 Contaminant Migration

Most of the AFFF releases from fire suppression systems and small spills discharged to the sanitary sewer system, and possibly to the stormwater system if discharge was outside of the building. Discharge to the sanitary sewer led to the Brunswick Sewer District WWTP, and as discussed above in Section 10.4.5, a defoaming chemical would be injected into the sanitary sewer system prior to leaving the former NAS Brunswick base to minimize impacts to the WWTP.

Discharges to the stormwater system, including the release from the cockpit fire and at least one release from Hangar 5, ultimately discharged to the former Picnic Pond stormwater retention system. Based on the MEDEP Spill Report P-198-1998 for the cockpit fire, impacts to the habitat in Picnic Pond were not visually observed and no harmful effects were detected or observed following the spill (MEDEP, 1998); however, no analytical data was collected. Based on the report for the August 14, 2002 release from testing the AFFF fire suppression system at Hangar 5, foam was observed to be coming out of the Night Flight Outfall (located at the eastern end of Pond B [Lower Impoundment Pond] of the Picnic Pond stormwater retention system) as late as August 20, 2002

following the release and cleanup activities. Note that PFCs are being evaluated in surface water and sediment in a separate investigation for the former Picnic Pond stormwater retention system.

Previous environmental investigations for PFOS and PFOA indicate their presence in groundwater at Site 11 and the Eastern Plume and the Building 611/555 Area. Based on groundwater flow in the Site 11 and the Eastern Plume area, PFOS and PFOA are likely to have migrated from Site 11 toward the Eastern Plume. Based on groundwater flow in the Building 611/555 Area, PFOS and PFOA are likely to migrate south toward Sites 1 and 3.

Where AFFF was used in the open (e.g., fire-fighting, fire training activities, fire vehicle operation and maintenance activities) PFCs would be carried in the surface run-off from these areas. Where runoff is allowed to infiltrate into the ground, PFCs could have entered environmental media (soils, water). Otherwise, the runoff would be routed through the former NAS Brunswick base's stormwater drainage system (e.g., to the Picnic Pond stormwater retention system).

Once PFCs reach groundwater, they will migrate with the groundwater flow system. Current literature (USEPA, 2013) suggests they are not strongly affected by attenuation processes, and so they are relatively persistent in groundwater systems.

10.5.3 Nature and Extent of PFCs

PFOS and PFOA were detected in groundwater at Site 11 and the Eastern Plume at concentrations that exceeded the PHAs as shown on **Figure 10-2**. The highest concentrations of PFOA were detected at two wells in the northern half of the Eastern Plume (monitoring well MW-EP347 [15 ug/L] and extraction well EW-05B [9.1 ug/L]) and at Site 11 monitoring well MW-323 (7 ug/L), located upgradient of the Eastern Plume and immediately east of Site 11. The locations with the highest concentrations of PFOS were at extraction well EW-05B (0.65 ug/L) and at Site 11 monitoring well MW-323 (1.2 J ug/L).

PFOS were detected in groundwater in the vicinity of Building 555 at concentrations that exceeded the PHAs as shown on **Figure 10-3**. The highest concentrations of PFOS were detected in wells MW-04S (0.3 ug/L) and MW-06S (0.36 ug/L). PFOA was detected in several wells, with the highest concentration in well MW-04S (0.1 ug/L), which is below the USEPA PHA (0.4 ug/L) but at the same concentration as the MECDC MEG (0.1 ug/L). Subsurface soil results indicate that PFOA was detected in two samples and PFOS was detected in three samples. All results were below the calculated soil screening level.

The previous investigations indicated the presence of PFOS and PFOA were present in groundwater, but did not define the nature and extent of these impacts. The planned investigation will supplement the previous investigations to further characterize the presence of PFOS and PFOA at

the former NAS Brunswick base where potential AFFF source areas may exist. The planned investigation will also evaluate background levels of PFOS and PFOA to determine if site concentrations of these compounds are within background levels. In addition, two separate investigations at the Eastern Flightline and the former Picnic Pond stormwater retention system are planned and the data from these investigations will supplement the planned investigation outlined in this SAP.

10.5.4 Routes of Exposure

There is no current human health exposure to groundwater at the Site. However, as the former NAS Brunswick base goes through redevelopment, there is the potential for future exposure. The Navy intends to implement land use controls, where needed, to minimize this future exposure.

10.6 Environmental Media Targeted for Planned Investigation

The planned investigation is designed to assess groundwater located in potential source areas, as well as background/upgradient areas, for the presence of PFOS and PFOA. Groundwater samples will also be collected from the GWETS and a total of 16 PFCs will be analyzed to determine the effectiveness of the GWETS on treatment of various PFCs.

SAP Worksheet #11: Project Quality Objectives/Systematic Planning Process Statements

[\(UFP-QAPP Manual Section 2.6.1\)](#)

The primary project quality objectives (PQO) of the planned investigation are to collect PFOS and PFOA data in groundwater in areas that may have been impacted by the release of AFFF from historic operations, to assess PFOS and PFOA in background conditions in groundwater, and to determine the effectiveness of the GWETS on treatment of various PFCs. The PQOs were developed for this investigation based on the *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA QA/G-4) (USEPA, 2006) and are presented below.

11.1 Step 1 - Problem Statement

The problem statement for this project includes the following:

- PFOS and PFOA have been detected in groundwater during prior investigation activities in three areas monitored at the former NAS Brunswick base. The continued presence and delineation of these compounds are unknown. Additional monitoring is required to determine the presence of these compounds in groundwater at the former NAS Brunswick base.
- The presence of PFOS and PFOA as background concentrations in groundwater is not known. Outside the former NAS Brunswick base, AFFF has been widely used for fire-fighting by the military and municipal fire departments. The PFC compounds found in AFFF are also used in cosmetics, personal care products, cleaning products, coatings on carpets, textiles leather and paper, paints, engineering coatings used in semiconductor manufacture, herbicides, insecticides, greases, lubricants and adhesives. They are now considered ubiquitous in the environment. The Navy's policy for the use of background chemical levels is to distinguish between evidence of release or disposal of hazardous substances in excess of reportable quantities caused by the Navy (a site release) and basewide background chemical levels (naturally occurring and anthropogenic). The Navy's policy requires basewide background levels in non-site areas to be established to ensure that cleanup levels for sites (spills, releases, disposal areas) are not less than background concentrations (both naturally occurring and anthropogenic).
- The effectiveness of the GWETS on PFCs is not known at this time. PFOS and PFOA have been detected in groundwater within the Eastern Plume, which is treated by the GWETS.

11.2 Step 2 – Study Goals

The specific study goals of the planned investigation are listed below.

- Goal 1 - Obtain a dataset that further evaluates the presence of PFOS and PFOA in potential source areas where AFFF was historically stored, used and/or released that may have impacted groundwater,
- Goal 2 - Determine background levels of PFOS and PFOA in groundwater in upgradient/non-site related areas and,
- Goal 3 – Obtain a dataset of 16 PFCs from the GWETS to determine its effectiveness on the treatment of various PFCs.

To achieve these goals and ensure that appropriate data quality is obtained, Project Screening Levels (PSLs) were identified. PSLs represent the levels that analytical data must meet in order to be of sufficient quality for use in the Investigation Summary Report. These levels are designed to be equal to or lower than criteria that may be used for risk management and remedial decisions. The PSLs are not intended to be used as cleanup levels. Refer to Worksheet #15 for the specific PSLs and associated sources.

11.3 Step 3 – Information Inputs

Information inputs will consist of environmental screening data and laboratory analytical data for groundwater samples from monitoring wells and the GWETS, as presented in this SAP. **Table 11-1** details the sampling rationale for the samples that will be collected during the investigation. **Figure 11-1** presents the planned groundwater sampling locations, as well as the locations of 17 monitoring wells proposed to be installed and sampled as part of this investigation. The following information inputs will be compiled to characterize groundwater conditions:

- Field parameters – pH, specific conductivity, turbidity, temperature, dissolved oxygen (DO), and oxidation-reduction potential (ORP) in groundwater.
- Laboratory analytical data – PFOS and PFOA in groundwater and 16 PFCs from samples from the GWETS.

11.4 Step 4 – Study Boundaries

The study area consists of monitoring wells in various areas as well as background areas within the former NAS Brunswick base. Refer to **Figure 10-1** for the regional location and **Figure 11-1** for the proposed sample locations. Spatial and temporal boundaries are described below.

Spatial Boundaries

The spatial boundaries for this study include potential source areas where AFFF was historically stored, used and/or released, downgradient from these areas, the GWETS, and upgradient/non-site

related areas within the former NAS Brunswick base. Potential source areas requiring further investigation are identified on **Table 10-1**. Proposed background monitoring wells including in this investigation are identified on **Table 11-1**. The locations of the proposed monitoring wells and the exact background monitoring wells to be sampled will be determined based on field conditions prior to the initial round of groundwater sampling.

Temporal boundaries

The temporal boundaries for this study will include one round of groundwater sampling, anticipated to occur during the fall of 2014.

11.5 Step 5 – Analytical Approach

The analytical approach for the planned investigation is to determine if the collected groundwater data indicate the presence of PFOS or PFOA above USEPA PHAs and/or the MECDC MEG groundwater criteria, then based on the results, determine the next steps in evaluating PFOS and PFOA at the former NAS Brunswick base. In addition, the collected groundwater data from the GWETS will be evaluated to determine its effectiveness on treatment of various PFCs.

11.6 Step 6 – Performance Criteria

The objective of this section is to complete the following:

- Identify potential sources of study error (e.g., field error, analytical error, etc.)
- Establish and identify the methods used to reduce potential sources of error
- Determine how decision errors will be managed during the project

Sampling Strategy

The sample design was developed to characterize potential source areas where AFFF was historically stored, used and/or released and may have impacted groundwater as well as evaluate the effectiveness of the GWETS on the treatment of various PFCs. Existing monitoring wells located at and/or downgradient from known release areas will be sampled as part of this investigation. A total of 17 monitoring wells will be installed to provide additional groundwater data in areas where AFFF impacts may be present. One round of sampling will be conducted, anticipated to occur in the fall of 2014. The specific quantities and parameters for the planned sampling design are provided in **Table 11-1** and Worksheet #17.

Potential Sources of Error

Potential sources of error in the investigation may be divided into two main categories: sampling errors and measurement errors. A sampling error can occur when the sampling design, planning, and implementation do not result in data that is representative for the site, for example, by improper sampling procedures or not adequately considering heterogeneity in the sampling design. A measurement error can occur when performance variance from laboratory instrumentation, analytical methods, and/or operator error occurs. USEPA identifies the combination of these errors as a "total study error" (USEPA, 2006). One objective of the planned investigation is to reduce the total study error so that decision-makers can be confident that the data collected accurately represent the chemical characteristics of the background groundwater.

Managing Decision Error

The investigation will utilize decision-error minimization techniques in sampling design, sampling methodologies, and laboratory measurement of compounds of interest. Possible decision errors will be minimized during the field investigation by using the following methods:

- Select sampling locations from properly-constructed and maintained monitoring wells.
- Use standard field sampling methodologies (presented in Worksheet #21). Perform sampling activities in accordance with the standard operating procedures (SOPs) referenced in this SAP.
- To the best extent practicable, eliminate the use of specific items (e.g., Teflon®, blue ice, etc.) to avoid cross contamination as described in Worksheet #14. .
- Use applicable analytical methods (presented in Worksheet #23) for sample analysis by a competent analytical laboratory certified by the DoD Environmental Laboratory Accreditation Program (ELAP) to reduce measurement errors.
- Confirm analytical data to identify and control potential laboratory error and sampling error by using spikes, blanks, and replicated samples.
- For analytical results that do not achieve desired PSLs, include a discussion of alternate information inputs as part of the conclusions and uncertainty analysis.

Decision errors associated with judgmental sampling are based on sample design and measurement errors. Assuming that the best possible professional judgment was used to develop the sampling plan (e.g., position sampling locations), the most important decision errors will be associated with field and laboratory techniques involved in the collection and analysis of the data.

Sampling Methods and Procedures

- Possible decision errors generated by sampling errors will be minimized during the field investigation by applying standardized field sampling methodologies (presented in Worksheet #21).
- To the best extent practicable, eliminate the use of specific items (e.g., Teflon®, blue ice, etc.) to avoid cross contamination as described in Worksheet #14.

Laboratory Measurement of Compounds of Interest

- Possible decision errors generated by laboratory measurement errors will be minimized by using applicable analytical methods (presented in Worksheet #23) for sample analysis by a competent analytical laboratory evaluated and certified by the DoD ELAP.

Managing Laboratory Sampling Error

Control of potential laboratory error and sampling error will be minimized by using spikes, blanks, and duplicates. Sampling error may be introduced when the laboratory chemist selects a single portion of the field sample for laboratory analysis. However, since the samples are aqueous, the probability of this type of error is low.

11.7 Step 7 – Obtaining the Data

The sampling design for the study area was developed to optimize resources and generate data to satisfy the PQOs. The critical objective is to obtain a dataset that further evaluates the presence of PFOS and PFOA in potential source areas where AFFF was historically stored, used and/or released that may have impacted groundwater as well as to determine background levels of PFOS and PFOA in groundwater at the former NAS Brunswick base. In addition, a dataset from the GWETS will be obtained to determine its effectiveness on treatment of various PFCs.

Field Screening

Field measurements will be recorded in a field logbook, onto field data collection sheets, and/or into an electronic field data collection device. Soil collected during the installation of the proposed 17 monitoring wells will be screening using a photoionization detector (PID) for volatile organic compounds (VOCs) to evaluate levels for health and safety purposes. Groundwater will be measured in the field for pH, specific conductivity, turbidity, temperature, DO, and ORP. Field data will be compiled and stored in project folders, for subsequent use in evaluating analytical data and completing the Investigation Summary Report.

Groundwater Sampling

One round of groundwater samples will be collected from four locations from the GWETS, 19 existing monitoring wells, and 17 additional monitoring wells to be installed as part of this investigation. The proposed sample locations are presented in **Figure 11-1** and the sampling rationale is presented in **Table 11-1**. The exact background monitoring wells to be sampled will be determined based on field conditions prior to the initial round of groundwater sampling. Additional details on the groundwater sampling are provided in Worksheet #14 and #17.

Analytical Laboratory Sample Management

The sample matrix, number of samples, and number and type of laboratory quality assurance and quality control (QA/QC) samples are summarized in the "Sample Details Table" of this SAP. Details on the analytical group, sample volumes, sample container specifications, preservation requirements, and maximum holding times are identified in combined Worksheet #18, #19, #20 and #30 of this SAP.

The laboratory will provide EQUIS electronic data deliverable files, portable document format (PDF) files of the data deliverables for all project data, and a hard copy of data deliverables for all results. Designated samples will be used to obtain necessary subsamples for laboratory QC measurements, which include laboratory duplicate samples and matrix spike/matrix spike duplicate (MS/MSD) samples. All analytical procedures will be performed in accordance with the laboratory SOPs.

Resolution will provide data validation services and verify and evaluate the usability of the data as identified in combined Worksheet #34 – 36 and Worksheet #37.

PDF copies of all analytical data packages will be stored on CD-ROM, archived in the NAVFAC LANT Administrative Record, and uploaded onto the Naval Installation Restoration Information Solution (NIRIS) system using the Navy Electronic Data Deliverable (NEDD) database format. All other data generated in the field and reports generated for the project will be stored as computer readable data files by Resolution. Laboratory data packages will be submitted electronically in MEDEP formatted electronic data deliverables (EDDs).

SAP Worksheet #12: Field Quality Control Samples – Groundwater

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Measurement Performance Criteria Table – Field QC Samples

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blanks	PFCs	One per 20 field samples per matrix per sampling equipment	Accuracy/Bias/Contamination	No target compounds > ½ LOQ , except for common laboratory contaminants, which must be < LOQ
Field Duplicates		One per 20 field samples per matrix	Precision	RPD ≤ 50%, if both results are ≥ 2 x LOQ
Matrix Spike/Matrix Spike Duplicate		One per 20 samples, per matrix, per preparation batch	Accuracy/Bias/Precision	Per DoD QSM Limits; Refer to Worksheets 28
Cooler Temperature Indicator		One per cooler	Representativeness	Temperature ≤ 6 degrees Celsius.

SAP Worksheet #14: Summary of Project Tasks

[\(UFP-QAPP Manual Section 2.8.1\)](#)

Well Condition Assessment

Prior to conducting the groundwater investigation, an initial site visit will be conducted to evaluate the condition of the existing monitoring wells and to mark out the locations of the 17 proposed new monitoring wells. The assessment will determine the accessibility and condition of each well (e.g., properly sealed, well damage, obstruction in wells, etc.) as well as determine if the existing monitoring wells need to be re-developed (based on, for example, visual turbidity or siltation within the well screen). Once the condition of the existing wells has been determined, the final selection of the background wells for the proposed sampling program will be determined (see **Table 11-1**). If some of the existing wells proposed for sampling are unable to be sampled (e.g., poor condition, not found), then alternative locations will be selected, or additional new monitoring wells may be proposed.

Utility Clearance

Prior to the initiation of intrusive field work (e.g., well drilling), utility clearance will be conducted in accordance with SOP 3-01 Utility Clearance. Monitoring well locations will be marked and both Dig Safe and the Navy's utility maps will be reviewed to identify underground utilities in the work areas. A utility locating subcontractor will also provide clearance of underground utilities.

Drilling and Monitoring Well Installation

A total of 17 overburden monitoring wells will be installed in the areas shown on **Figure 11-1**. The exact location of the monitoring wells will be determined during the initial site visit. The rationale for monitoring well installation is provided on **Table 11-1**.

The monitoring wells will be advanced using hollow stem auger drilling methods. Soil samples will be continuously collected via split spoons for visual description and logged in accordance with SOP 3-16 Soil and Rock Classification. Soil samples will not be submitted for laboratory analysis as part of this field investigation. Soil will be screened for VOCs using a PID for health and safety purposes and measurements will be recorded in relevant field logs.

The soil borings will be advanced to a total depth of five feet below the water table and will be completed as monitoring wells. The monitoring wells will be constructed with a 10-foot screen installed across the water table. Because the new monitoring wells are intended to be located at or near potential source areas, the shallowest groundwater is most likely to be impacted. The monitoring wells will be constructed in accordance with SOP 3-12 Monitoring Well Installation. The well will consist of a #00 sand or equivalent filter pack and 0.010 inch slot screen. Soil cuttings will

be containerized as Investigative-Derived Waste (IDW) and managed in accordance with SOP 3-05 Investigation Derived Waste Management.

Monitoring Well Development

Following installation, the newly installed monitoring wells, and the existing monitoring wells deemed necessary for re-development, will be developed/re-developed in accordance with SOP 3-13 Monitoring Well Development. Well development will not commence until at least 24 hours after well installation. Monitoring wells will be developed until turbidity is equal to or less than 10 nephelometric turbidity units (NTU), if possible. If turbidity less than 10 NTUs is not possible, development will continue until turbidity readings are stable in accordance with SOP 3-13 Monitoring Well Development, or until 2 hours of well development has elapsed, whichever is sooner. No development equipment, supplies, or personal protective equipment (PPE) containing Teflon® will be used during well development. Development fluids will be containerized as IDW and managed in accordance with SOP 3-05 Investigation Derived Waste Management.

Water Level Measurements

Prior to groundwater purging and sampling, synoptic water level measurements will be collected from the proposed monitoring wells to be sampled. Water levels will be measured on the same day in the shortest time span possible and not during or immediately following a large rain event. Static water levels measurements will be obtained with an electronic water level indicator with a weighted cored that is accurate to 0.01 feet. The depth of water in the well will be measured from the surveyed elevation mark on the top of the inner well casing. The well name, date, time, depth to water, total depth and any other well details (e.g., well condition) will be recorded in the field logbook or appropriate field form.

The water level indicator will be decontaminated between monitoring locations to prevent cross-contamination in accordance with procedures in SOP 3-06 Equipment Decontamination.

Groundwater Quality Monitoring and Sample Collection

Following development, the monitoring wells will be allowed to stabilize for at least 1 week prior to groundwater gauging and sampling. The monitoring wells will be gauged and sampled in accordance with SOP 3-14 Monitoring Well Sampling and USEPA Region 1 Low-Flow Sampling Guidance (USEPA, 2010). The procedures for well purging and parameter stabilization are provided in the SOP. To the extent practicable, the following measures will be taken during the sampling process to avoid sample contamination during PFC sample collection:

- Sample personnel should not use Post-it Notes at any time during sample handling, or mobilization/demobilization.

- Sample personnel should wear only old, well laundered (at least 6 washings since purchase) clothing.
- Sample personnel should not wear water resistant clothing (e.g., Gore-Tex®) prior or during sample collection.
- Tyvek® suits must not be worn during sample handling.
- Powderless nitrile glove must be worn at all times while collecting and handling samples.
- Many food and snack products are packaged in wrappers treated with PFCs. Therefore, hands will be thoroughly washed after handling fast food, carryout food, or snacks.
- Pre-wrapped food or snacks (like candy bars, microwave popcorn, etc.) must not be in the possession of the sampling personnel during sampling.
- Blue ice must not be used to cool samples or be used in sample coolers.
- Products containing Teflon® will not be used during sample handling, or mobilization/demobilization.
- Aluminum foil must not be used during sample handling.

Groundwater will be measured in the field for water level, pH, specific conductivity, turbidity, temperature, DO, and ORP. Groundwater samples will be placed into laboratory-supplied containers, and transported off-site for analysis of PFOS and PFOA. Purge water will be containerized as IDW and managed in accordance with SOP 3-05 Investigation Derived Waste Management.

GWETS Sample Collection

Four groundwater samples will be collected from the GWETS, and will include samples from:

- the plant groundwater influent,
- the HiPOx system effluent,
- the liquid GAC system mid-point, and
- the plant groundwater effluent.

Groundwater will be placed into a temporary container and one round field measurements will be collected, including pH, specific conductivity, turbidity, temperature, DO, and ORP. Groundwater samples will be placed into laboratory-supplied containers, and transported off-site for analysis of 16 PFCs.

Quality Assurance/Quality Control

The QA/QC sample collection frequency is as follows (also shown in Worksheet #12):

- **Equipment blanks** - 1 per 20 samples
- **Field duplicates** – (single blind samples) 1 per 20 samples
- **MS/MSD or MS/Matrix Duplicate** - 1 per 20 samples

QA/QC samples will be collected in at least one location where submersible stainless steel bladder pumps are used.

Equipment Decontamination

To the maximum extent possible, Resolution will utilize dedicated and disposable sampling equipment to avoid the potential for cross contamination of samples due to inadequate decontamination processes. The dedicated/disposable sampling equipment will include a disposable polyethylene tubing, disposable gloves, and laboratory supplied sample bottles. Due to potential sample contamination, the measures listed above for sampling will also be followed, to the extent practicable, for equipment decontamination.

Non-disposable or non-dedicated sampling equipment (e.g., auger flights, split spoon samplers, surge blocks, water level indicators, water quality meters, etc.) will be decontaminated prior to sampling and between samples in accordance with SOP 3-06 Equipment Decontamination. Cleaning of equipment is performed to prevent cross-contamination between samples and to maintain a clean working environment for all personnel. Decontamination will generally consist of a water rinse station to remove gross contamination (if needed), followed by a non-phosphate detergent (e.g., Alconox®) water rinse, and a rinse with de-ionized water. If smaller equipment is to be stored or transported, it will be wrapped in plastic after air-drying. The downhole drilling equipment will be decontaminated after the borehole. All decontamination water generated during decontamination of sampling equipment will be containerized as IDW and managed in accordance with SOP 3-05 Investigation Derived Waste Management.

Investigation-Derived Waste Management

IDW will be managed in accordance with SOP 3-05 Investigation Derived Waste Management and is expected to consist of drill cuttings, purge/well development water, water generated during decontamination processes and personal protective equipment (PPE). IDW generated during well installation, development/sampling and decontamination activities will be collected in properly labeled 55-gallon drums, sampled for waste characterization, and temporarily staged on-site for subsequent off-site disposal.

Land Surveying

A survey of the monitoring wells will be conducted at the end of the field program by a Maine-licensed surveyor under the direct supervision of Resolution. The location will be tied into the existing basemap developed for the former NAS Brunswick base. After the monitoring well is installed, a notch or mark will be made at the top of the inner casing. The vertical location of this point will be surveyed to a reference point determined in the field and reported to 0.01 of a foot. All elevations will be referenced to the North American Vertical Datum (NAVD) 1988. The horizontal co-ordinates will be measured with an accuracy of 0.1 foot.

Should temporary survey coordinates be necessary, a portable global position system (GPS) unit will be used in accordance with SOP 3-07 Land Surveying.

Laboratory Coordination, Data Management and Validation

Resolution's Project Chemist will track the samples from collection through analysis and obtaining data packets from the laboratories within the appropriate turnaround time (TAT) of sample receipt. A signed certificate of analysis will be provided in the narrative section of each laboratory data package. The laboratory will submit the data in hard copy and an electronic format per the Electronic Data Deliverable (EDD) format specified by Resolution.

Analytical results will be validated according to the procedures in Worksheet #36. The validated analytical data will then be converted and/or verified as compliant with the Navy's NEDD format, and uploaded into the Navy's NIRIS database. Other data generated in the field, as well as reports produced for this project, will be uploaded into appropriate portions of NIRIS, packaged in the appropriate formats (e.g., hard copy and/or electronic), and submitted to the appropriate document distribution lists provided by the Navy.

SAP Worksheet #15: Reference Limits and Evaluation Table

[\(UFP-QAPP Manual Section 2.8.1\)](#)

Matrix: Groundwater

Analytical Group: PFCs

Preparation and Analysis Method: Laboratory Proprietary/SOPs: DV-OP-0019, DV-LC-0012

Data Type (definitive or screening): Definitive

The table below identifies the PSLs and comparison of PSLs to analytical reference limits (i.e., LODs, LOQs and DLs) for groundwater. The PSLs represent the levels that analytical data must meet in order to be of sufficient quality for use in the Investigation Summary Report. These levels are designed to be equal to or lower than criteria that may be used for risk management and remedial decisions. The PSLs are not intended to be used as cleanup levels. The sources considered for development of PSLs are referenced at the bottom of the tables.

Analyte	CAS No.	Project Screening Level (PSL) (µg/L)	PSL Reference	Project Quantitation Limit (PQL) Goal (µg/L)	Laboratory Specific Limit		
					Limit of Quantitation (LOQ)	Limit of Detection (LOD)	Detection Limit (DL)
Groundwater Sampling							
Perfluorooctanoic acid, PFOA	335-67-1	0.1	1	0.04	0.02	0.01	0.00979
Perfluorooctane sulfonate, PFOS	1763-23-1	0.1	1	0.06	0.03	0.02	0.0133
GWETS Sampling							
Perfluorooctanoic acid, PFOA	335-67-1	0.1	1	0.04	0.02	0.01	0.00979
Perfluorooctane sulfonate, PFOS	1763-23-1	0.1	1	0.06	0.03	0.02	0.0133

Analyte	CAS No.	Project Screening Level (PSL) (µg/L)	PSL Reference	Project Quantitation Limit (PQL) Goal (µg/L)	Laboratory Specific Limit		
					Limit of Quantitation (LOQ)	Limit of Detection (LOD)	Detection Limit (DL)
Perfluorobutane sulfonate (PFBS)	29420-43-3	-	-	0.04	0.02	0.009	0.00824
Perfluorobutanoic acid (PFBA)	375-22-4	-	-	0.04	0.02	0.01	0.00980
Perfluorodecane sulfonate (PFDS)	67906-42-7	-	-	0.04	0.02	0.01	0.00915
Perfluorodecanoic acid (PFDA)	335-76-2	-	-	0.04	0.02	0.01	0.00782
Perfluorododecanoic acid (PFDoA)	307-55-1	-	-	0.06	0.03	0.02	0.0149
Perfluoroheptanoic acid (PFHpA)	375-85-9	-	-	0.06	0.03	0.02	0.0132
Perfluorohexane sulfonate (PFHxS)	108427-53-8	-	-	0.06	0.03	0.01	0.00697
Perfluorohexanoic acid (PFHxA)	307-24-4	-	-	0.04	0.02	0.01	0.00291
Perfluorononanoic acid (PFNA)	375-95-1	-	-	0.08	0.04	0.02	0.0174
Perfluorooctane sulfonamide (PFOSA)	754-91-6	-	-	0.10	0.05	0.015	0.00571
Perfluoropentanoic acid (PFPeA)	2706-90-3	-	-	0.06	0.03	0.01	0.0109
Perfluorotetradecanoic acid (PFTeA)	376-06-7	-	-	0.06	0.03	0.02	0.0147
Perfluorotridecanoic acid (PFTriA)	72629-94-8	-	-	0.08	0.04	0.02	0.0177
Perfluoroundecanoic acid (PFUnA)	2058-94-8	-	-	0.04	0.02	0.01	0.00689

Notes:

1 - Maine Center for Disease Control and Prevention (MECDC) Maximum Exposure Guideline (MEG), 2014.

SAP Worksheet #17: Sampling Design and Rationale

[\(UFP-QAPP Manual Section 3.1.1\)](#)

17.1 Overview

This section describes the sampling rationale and sampling design for the collection of PFOS and PFOA in groundwater samples and 16 PFCs from groundwater at the GWETS at the former NAS Brunswick base. Groundwater samples will be collected from four locations from the GWETS, 19 existing monitoring wells, and 17 newly installed monitoring wells. The planned investigation is designed to determine levels of PFOS and PFOA in groundwater in potential source areas where AFFF was historically stored, used and/or released and to evaluate the effectiveness of the GWETS on various PFCs at the former NAS Brunswick base. Groundwater samples will be collected during the fall of 2014. To the extent practicable, the measures described in Worksheet #14 will be taken during the sampling process to avoid sample contamination during PFC sample collection.

Details regarding the specific data quality objectives (DQOs) for the planned investigation are presented in Worksheet #11. PSLs are presented in Worksheet #15. The PSLs represent the limits of detection that analytical data should meet in order to be of sufficient quality for use in the Investigation Summary Report. These levels are designed to be equal to or lower than applicable criteria that will be used. However, the PSLs are not intended to be used as cleanup levels or to identify the presence of risk/hazard. The following paragraphs describe the general methodology and rationale for the specific sampling approach.

17.2 Field Screening

Field parameters will consist of measurements associated with this sampling program. During the advancement of soil borings, soil will be screened for VOCs using a PID for health and safety purposes and measurements will be recorded in relevant field logs. Groundwater measurements of pH, specific conductivity, turbidity, temperature, DO and ORP will be recorded in relevant field logs. These field parameters will be used to determine when wells have been purged sufficiently. They also provide specific information about groundwater chemistry. The specific methodology and procedures to be implemented for field parameters are included within the SOPs provided with this SAP.

17.3 Groundwater Quality Monitoring and Sample Collection

Seventeen overburden groundwater monitoring wells will be constructed during the planned investigation. Their general location is shown on **Figure 11-1**; however, the exact location of the wells will be determined after the initial site visit to determine the accessibility of some locations as

well as to determine drainage patterns for some wells (e.g., those along the Flight Line). The rationale for monitoring well installation is provided on **Table 11-1**.

During well installation, soil samples will be collected continuously to obtain visual description of the material that may be encountered as well as to screen soils in areas with known VOCs (e.g., Eastern Flightline). Each well will be constructed with a 10-foot well screen installed across the water table. At least 24 hours will be allowed between installation and well development. If any of the 19 existing wells require re-development, they will be developed prior to groundwater sampling. After development, monitoring wells will be allowed to stabilize for at least 1 week before returning to the monitoring wells for groundwater sampling.

Prior to groundwater purging and sampling, synoptic water level measurements will be collected from the proposed monitoring wells to be sampled. Water levels will be measured on the same day in the shortest time span possible and not during or immediately following a large rain event.

Groundwater samples will be collected from the 17 newly installed monitoring wells and from 19 existing monitoring wells. The proposed monitoring wells for groundwater sampling are provided on **Table 11-1**. Several existing monitoring wells have been previously designated as representing background conditions (TetraTech, 2012), and were selected such that they are not located downgradient of AFFF storage, use and/or release areas. Although several wells are listed for the background wells, only one well will be selected from each grouping and will be based on the accessibility and/or the condition of the well.

Groundwater sampling methods may include peristaltic or submersible bladder pumps based on the depth of water within each well and may be determined during the initial well assessment as to which sampling method is appropriate for each well. Peristaltic pumps can be used for sampling, since the parameter list does not include any volatile or organic constituents. However, peristaltic pumps cannot be used where water levels are too deep. In these circumstances, bladder pumps will be used. Groundwater samples will be analyzed for PFOS and PFOA. In addition to the primary samples, QA/QC samples will be collected in accordance with this SAP.

Samples will be shipped to the designated laboratory(ies) or picked up by laboratory courier on the day of sampling or as soon as logistically possible. The samples will be preserved, chilled, and stored in accordance with this SAP. All sample shipments to a designated laboratory will contain appropriate chain of custody documentation.

17.4 GWETS Sample Collection

Four groundwater samples will be collected from the GWETS, and will include samples from:

- the plant groundwater influent,
- the HiPOx system effluent,
- the liquid GAC system mid-point, and
- the plant groundwater effluent.

Groundwater will be placed into a temporary container and one round field measurements will be collected, including pH, specific conductivity, turbidity, temperature, DO, and ORP. Groundwater samples will be analyzed for 16 PFCs. In addition to the primary samples, QA/QC samples will be collected in accordance with this SAP.

Samples will be shipped to the designated laboratory(ies) or picked up by laboratory courier on the day of sampling or as soon as logistically possible. The samples will be preserved, chilled, and stored in accordance with this SAP. All sample shipments to a designated laboratory will contain appropriate chain of custody documentation.

SAP Worksheet #18, 19, 20 and 30: Field Project Implementation (Field Project Instructions)

[\(UFP-QAPP Manual Sections 3.1.1 and 3.5.2.3\)](#)

The laboratory information is based upon information provided by the selected laboratory:

Laboratory Name and Address: TestAmerica, 4995 Yarrow Street, Arvada, Colorado

Point of Contact Name: TestAmerica, Debra Henderer, Client Relations Manager

Phone Number: 303.736.0134

ELAP Certification: 2907.01 (expires October 31, 2015)

Matrix	Number of Samples	Analytical Group ¹	Analytical and Preparation Method / SOP Reference ²	Containers (number, size, and type)	Sample Volume (units) ³	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time ⁴ (preparation / analysis)
Groundwater	40	PFCs	Laboratory Proprietary / TestAmerica/DV-OP-0019, DV-LC-0012	One 16 oz HDPE bottle, with no Teflon liner in screw cap	16 oz	Cool to ≤ 6°C	14 days/40 days

Notes:

1. Refer to Worksheet #15 for specific target analytes.
2. Refer to the Analytical SOP References table (Worksheet #23).
3. Minimum sample volume requirement.
4. There is no prescribed holding time for this method. These compounds are known to be highly persistent in the environment and are expected to remain stable well beyond the holding times listed in this table. These limits are advisory only.

C - Celsius

HDPE – high-density polyethylene

oz - ounce

A total of four groundwater samples from the GWETS and 36 monitoring wells will be selected for groundwater sampling based on the wells presented in Worksheet #11. Samples will be identified using a unique sample identification system. Sample nomenclature will be based on the sample locations presented in Worksheet #11, and will adhere to the following scheme:

Field Samples

Field samples will be named using the following conventions. The backslashes in the descriptions are included to separate each section of the description but will not be included in the sample identification.

Groundwater: Sample Type/Sample Location Number/Event Code

Sample Type

Sample type will consist of two characters:
GW – Groundwater

Sample Location Number

Sample location numbers that will be used are those presented on Worksheet #11. For example, MW-318.

Field Duplicate

Duplicate samples only will have the following two characters:
FD – Field Duplicate

Event Code

The event code will consist of the month, day and year in the following format:
01Jan2014

An example sample name would be GW-MW-318-01Jan2014. An example duplicate sample name would be GW-MW-318FD-01Jan2014.

GWETS Samples

Samples collected from the GWETS will use the following conventions.

Groundwater: Sample Type/Sample Location/Event Code

Sample Type

Sample type will consist of:
GWETS – Groundwater Extraction Treatment System

Sample Location

Sample locations will consist of the following:
INF – Plant influent
HIPOXEFF – High-pressure oxygen system effluent
GACMID – Granular activated carbon system mid-point
EFF – Plant effluent

Field Duplicate

Duplicate samples only will have the following two characters:

FD – Field Duplicate

Event Code

The event code will consist of the month, day and year in the following format:

01Jan2014

An example sample name would be GWETS-INF-01Jan2014. An example duplicate sample name would be GWETS-INF-FD-01Jan2014.

Field QC Samples

Field QC samples will be named using the following convention.

QC Type

QC type will consist of two characters:

EB – Equipment (rinsate) Blank

Matrix spike/matrix spike duplicates and matrix duplicates will be noted on the chains of custody, but since they consist of only additional volume for a field sample, no distinct nomenclature is required.

Date

Date will consist of six numbers for MMDDYY.

Number

Number will consist of two digits. Each sample type will be numbered sequentially on a daily basis.

An example equipment blank sample would be EB-010114-01.

SAP Worksheet #21: Project Sampling SOP References Table

[\(UFP-QAPP Manual Section 3.1.2\)](#)

Below is a list of Standard Operating Procedures (SOPs) that shall be referenced during implementation of this SAP. Copies of SOPs are provided in **Appendix A**.

Reference Number	Title, Revision Date and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
3-01	Utility Clearance	Resolution	Air Knife	N	
3-02	Log Books	Resolution		N	
3-03	Record Keeping, Sample Labeling, and Chain-of-Custody	Resolution		N	
3-04	Sampling Handling, Storage and Shipping	Resolution		N	
3-05	IDW Management	Resolution		N	
3-06	Equipment Decontamination	Resolution		N	Avoid specific items (e.g., Teflon®) listed in Worksheet #14 to avoid cross-contamination with samples.
3-07	Land Surveying	Resolution		N	
3-12	Monitoring Well Installation	Resolution	Hollow Stem Auger Drill Rig	N	
3-13	Monitoring Well Development	Resolution	Surge Block, Bailer, Submersible Pump, Water Level Meter	N	Avoid specific items (e.g., Teflon®) listed in Worksheet #14 to avoid cross-contamination with samples.
3-14	Monitoring Well Sampling	Resolution	YSI, Turbidity Meter, Peristaltic Pump and/or Submersible Bladder Pump, Oil Water Interface Probe	N	Avoid specific items (e.g., Teflon®) listed in Worksheet #14 to avoid cross-contamination with samples.

Reference Number	Title, Revision Date and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
3-16	Soil and Rock Classification	Resolution		N	
3-20	Operation and Calibration of a Photoionization Detector	Resolution	PID	N	
3-24	Water Quality Parameter Testing	Resolution	YSI, Turbidity Meter, Peristaltic Pump and/or Submersible Bladder Pump	N	
3-33	Subsurface Soil Sampling by Split Spoon	Resolution	Hollow Stem Auger Drill Rig	N	

SAP Worksheet #23: Analytical SOP References Table

[\(UFP-QAPP Manual Section 3.2.1 – Worksheet #23\)](#)

Laboratory Name and Address: TestAmerica, 4995 Yarrow Street, Arvada, Colorado

Point of Contact Name: TestAmerica, Debra Henderer, Client Relations Manager

Phone Number: 303.736.0134

ELAP Certification: 2907.01 (expires October 31, 2015)

A copy of TestAmerica's ELAP Certification is provided in **Appendix B**.

TestAmerica SOP Number	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM ¹	Modified for Project Work? (Y/N)
DV-LC-0012	Revision 9.2, 07/13/2012 Analysis of Perfluorooctanoic Acid (PFOA) and other Perfluorinated Hydrocarbons (PFCs) and Perfluorinated Hydrocarbon Sulfonates (PFSS) in Water and Soil by LC/MS/MS	Definitive	PFCs Water & Soil	LC/MS/MS	N	N
DV-OP-0019	Revision 3, 03/4/2013 Extraction of Perfluorooctanoic Acid (PFOA) and Perfluorooctanoic Sulfonate (PFOS) and other Perfluorinated Hydrocarbons (PFCs) in Water and Soil	Preparation	Organic Prep, Water & Soil	N/A	N	N

SAP Worksheet #28 – Laboratory QC Samples Table

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Water

Analytical Group: PFCs

Analytical Method/SOP Reference: DV-LC-0012

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits ¹	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1/Batch (20 samples)	No Target Compounds > 1/2RL; no common lab contaminants > RL.	If sufficient sample is available, reanalyze samples. Qualify data as needed. Report results if sample results > 10x blank result or sample results ND.	Analyst / Section Supervisor	Accuracy/Bias- Contamination	No Target Compounds > 1/2RL; no common lab contaminants > RL.
Laboratory Control Sample	1/Batch (20 samples)	Refer to SOP DV-LC- 0012 for LCS control limits.	If sufficient sample is available, reanalyze samples. Qualify data as needed.	Analyst / Section Supervisor	Accuracy/Bias	Laboratory % Recovery Control Limits
Matrix Spike/Matrix Spike Duplicate	1/Batch (20 samples)	Refer to SOP DV-LC- 0012 for MS control limits.	Determine root cause; flag MS/MSD data; discuss in narrative.	Analyst / Section Supervisor	Accuracy/Bias/ Precision	Laboratory % Recovery / RPD Control Limits
Surrogates	Every sample and standards	Refer to SOP DV-LC- 0012 for Surrogate control limits.	Check calculations and instrument performance; recalculate, reanalyze.	Analyst / Section Supervisor	Accuracy/Bias	Laboratory % Recovery Control Limits

Notes:

1 - This is a summary of the acceptance criteria; refer to the method SOP for specific or more information.

SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

**SAP Worksheet #34, 35, 36: Data Verification and Validation (Steps I and IIa/IIb)
Process Table**

[\(UFP-QAPP Manual Section 5.2.1\)](#), [\(UFP-QAPP Manual Section 5.2.2\)](#), [\(Figure 37 UFP-QAPP Manual\)](#), [\(Table 9 UFP-QAPP Manual\)](#)

Data Review Input	Description	Responsible for Verification (Name, Organization)	Internal/ External
Verification (Step I):			
Review of CoC forms Sample Login/Receipt	The laboratory sample custodians will review the sample shipment for completeness, integrity, and sign accepting the shipment. All sample labels will be checked against the chain-of-custody form, and discrepancies will be identified, investigated, and corrected. The samples will be logged in at every storage area and work station required by the designated analyses. Individual analysts will verify the completeness and accuracy of the data recorded on the forms.	Lab QA Manager TestAmerica	Internal
Analytical Data Package	All analytical data packages will be verified for completeness and compliance with the SAP requirements prior to client submittal.	Lab Manager TestAmerica	Internal
Review of field procedures	Determine whether field procedures are performed in accordance with this SAP and prescribed procedures.	Field Team Leader	Internal
Review of field notes	Determine whether field procedures are performed in accordance with this SAP and prescribed procedures. Notes allow reconstruction of activities and identification of sampling locations.	Field Team Leader	Internal
Review of field instrument calibration sheets	Determine whether the field measurements occurred in accordance with manufacturer's instructions.	Field Team Leader	Internal
Review of CoC forms Sample Login/Receipt	Determine whether samples are labeled and handled in accordance with this SAP and prescribed procedures, and the correct analysis is selected.	Project chemist or data validators, Resolution Consultants	External
Sample Completeness	Verify that results for all samples submitted to the laboratory have been provided.	Project chemist or data validators, Resolution Consultants	External
Analytical Methods	Verify that analytical methods specified in this SAP were used for the analyses.	Project chemist or data validators, Resolution Consultants	External
Analyte Lists	Determine whether all analytes specified in Worksheet #15 were analyzed and reported by the laboratory.	Project chemist or data validators, Resolution Consultants	External
Limits of Quantitation	Verify that the results were reported at or below the project specific limits of quantitation listed in Worksheet #15.	Project chemist or data validators, Resolution Consultants	External
Case Narrative	Case narrative is reviewed to ensure all method deviations, corrective actions, reanalysis, data qualification, and laboratory qualifiers are adequately documented.	Project chemist or data validators, Resolution Consultants	External
Data Package Completeness	Verify that all relevant laboratory internal QC data have been provided.	Project chemist or data validators, Resolution Consultants	External

Data Review Input	Description	Responsible for Verification (Name, Organization)	Internal/ External
Sample condition upon receipt	Sample receipt condition is reviewed for sample temperatures and preservation, evidence of CoC, and integrity of samples.	Project chemist or data validators, Resolution Consultants	External
Analysis and extraction dates and times	Analysis and extraction are examined to determine if samples were analyzed within holding times. Note that PFOA/PFOS holding times are advisory only.	Project chemist or data validators, Resolution Consultants	External
Surrogate recoveries	Surrogate recoveries are compared to criteria in Worksheet #28.	Project chemist or data validators, Resolution Consultants	External
QC sample results	QC sample frequency and results (laboratory control samples, method blanks, and matrix spike sample results) are compared to criteria in Worksheet #28.	Project chemist or data validators, Resolution Consultants	External
Equipment blanks	Blank collection frequency is compared to frequency requirement in Worksheet #12.	Project chemist or data validators, Resolution Consultants	External
Field Duplicates	Field duplicate frequency and RPD are compared to criteria in Worksheet #12.	Project chemist or data validators, Resolution Consultants	External
Laboratory Electronic Deliverables	Determine whether electronic and hard copy data upon receipt are comparable and contain the proper reporting format. The assessment will consist of reviewing both types of data to verify that data were delivered in proper fields and that all required fields are populated correctly.	Project chemist or data validators, Resolution Consultants	External

Data Review Input	Description	Responsible for Verification (Name, Organization)	Internal/ External														
Compliance and Comparison (Steps IIa and IIb)																	
Assignment of qualifiers	<p>For the fixed-laboratory data, limited validation will be performed using criteria for the methods listed in Worksheet #'s 12, 15, and 28, the DoD QSM v 4.2, laboratory work order, and laboratory SOPs. If not addressed in the worksheets or DoD QSM, the logic outlined in the National Functional Guidelines for Superfund Organic Methods Data Review (October 2013) will be used as applicable to apply qualifiers to data.</p> <p>Assign qualifiers as necessary using the referenced guidance. The following qualifiers shall be used to indicate QC deficiencies:</p> <table><tr><th>Qualifier</th><th>Definition</th></tr><tr><td>J</td><td>The concentration is an estimated quantity</td></tr><tr><td>J+</td><td>The result is an estimated quantity, but the result may be biased high.</td></tr><tr><td>J-</td><td>The result is an estimated quantity, but the result may be biased low.</td></tr><tr><td>U</td><td>Compound was analyzed for but not detected</td></tr><tr><td>UJ</td><td>The sample quantitation limit is an estimated quantity</td></tr><tr><td>R</td><td>The data are rejected and unusable</td></tr></table> <p>Data qualifiers will be provided in summary results tables in the validation report for each data package. Data qualifiers will also be added to the EQuIS database.</p>	Qualifier	Definition	J	The concentration is an estimated quantity	J+	The result is an estimated quantity, but the result may be biased high.	J-	The result is an estimated quantity, but the result may be biased low.	U	Compound was analyzed for but not detected	UJ	The sample quantitation limit is an estimated quantity	R	The data are rejected and unusable	Project chemist or data validators, Resolution Consultants	External
Qualifier	Definition																
J	The concentration is an estimated quantity																
J+	The result is an estimated quantity, but the result may be biased high.																
J-	The result is an estimated quantity, but the result may be biased low.																
U	Compound was analyzed for but not detected																
UJ	The sample quantitation limit is an estimated quantity																
R	The data are rejected and unusable																
Sample chronology (instrument and extraction logs)	Sample chronology is reviewed for consistency with reported data and that samples were extracted and analyzed in appropriately sized QC batches with method specified QC samples.	Project chemist or data validators, Resolution Consultants	External														
Instrument specific information (GC-MS tunes)	Instrument specific information is evaluated against method specific requirements.	Project chemist or data validators, Resolution Consultants	External														
Initial Calibrations	Initial calibrations are evaluated for compliance with method specific requirements.	Project chemist or data validators, Resolution Consultants	External														
Initial and continuing calibration verifications	Initial and continuing calibration verifications are evaluated for compliance with method specific requirements.	Project chemist or data validators, Resolution Consultants	External														
Initial and continuing calibration blanks	Initial and continuing calibration blanks are evaluated for compliance with method specific requirements.	Project chemist or data validators, Resolution Consultants	External														
Internal standards	Internal standards are evaluated for compliance with method specific requirements.	Project chemist or data validators, Resolution Consultants	External														

Notes:

IIa=compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.]

IIb=comparison with measurement performance criteria in the SAP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005]

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Tables

Table 10-1
Potential Aqueous Film-Forming Foam Source Areas
Perfluorinated Compounds in Groundwater
Sampling and Analysis Plan
Former Naval Air Station Brunswick
Brunswick, Maine

Location	AFFF Activity	Storage			Spills			Potential Source	Source
		Number of Containers	AST/Container	Capacity (Gallons)	Date	Amount (Gallons)	Details		
Site 11 Former Fire Training Area	Area was used for fire-fighting training activities for 30 years ending in 1990.	--	--	--	Unknown	Unknown	Intentional releases of AFFF for fire training purposes over a 30 year period.	Yes	TetraTech, 2012. Sampling and Analysis Plan Perfluorinated Compounds in Groundwater Site 11 and Eastern Plume, Former Naval Air Station Brunswick, Maine. July 2012. TetraTech, 2014. Technical Memorandum Perfluorinated Compounds in Groundwater Site 11 and The Eastern Plume Former Naval Air Station, Brunswick, Maine. July 30, 2014.
Eastern Plume	Downgradient from activities related to Site 11.	--	--	--	--	--	--	Yes	TetraTech, 2012. Sampling and Analysis Plan Perfluorinated Compounds in Groundwater Site 11 and Eastern Plume, Former Naval Air Station Brunswick, Maine. July 2012. TetraTech, 2014. Technical Memorandum Perfluorinated Compounds in Groundwater Site 11 and The Eastern Plume Former Naval Air Station, Brunswick, Maine. July 30, 2014.
Flightline (Runway and Apron Areas)	Fire extinguishing activities relating to airport operations.	--	--	--	4/25/1998	110	Cockpit fire on tarmac. Spill was diluted by 3,000 gallons of water. Discharge was to the stormwater system.	Yes	TetraTech, 2011. Revised Final RCRA Partial Closure Report For Runway Area and Airfield Parking Apron Area, NAS Brunswick, ME. November 1, 2011. NIRIS #2529 TetraTech, 2011. Addendum To RCRA Partial Closure Report For Runways Area and Airfield Parking Apron Area, NAS Brunswick, ME. December 1, 2011. NIRIS #2492 Maine Department of Environmental Protection (MEDEP), 1998. MEDEP Oil & Hazardous Material Report Form. Spill Number P-198-1998 (P-0198-98). April 25, 1998.
West Fire Training Area (WFTA)	<p>Waste solvents and fuels were historically placed in a steel tank and then transported to a concrete pad in an area known as the West Fire Training Area. The tank was then ignited to determine the response time of the NAS fire department to extinguish the fire.</p> <p>Investigation activities conducted in 2010 reported no impacts from the fire-training activities.</p> <p>Based on information provided from the former deputy fire chief and the former program manager for fire and emergency services, the WFTA pre-dates the former NAS Brunswick's use of AFFF.</p>	--	--	--	--	--	--	No	<p>TetraTech, 2010. Work Plan Areas of Potential Interest Screening Investigations, Mercury Disposal Area, West Fire Training Area, Helipad Area and Former Buildings 7 and 10, NAS Brunswick, ME. September 16, 2010. NIRIS #2371</p> <p>Department of the Navy, 2010. Finding of Suitability to Transfer Airport Public Benefit Conveyance Parcel 1. December 2010. NIRIS #2143</p> <p>McMahon, Marty. Former Program Manager for Fire and Emergency Response for Naval Air Station Brunswick, Maine. Personal interview. July 8, 2014.</p> <p>Lewis, Dave. Former Deputy Fire Chief for Naval Air Station Brunswick, Maine. Telephone interviews dated July 14, 2014 and August 13, 2014. Various email communications.</p>
Fire Training Area (North of Hangar 6)	A former fire-fighting training area was located north of the Hangar 6 parcel parking area, on the abandoned runway. A stainless-steel aircraft mock-up containing propane jets were ignited for fire-fighting training activities. The mock aircraft and propane tanks were later removed. No liquid petroleum fuel was used during the fire-training activities. No reported impacts from the fire-training activities were reported. According to the former deputy fire chief, only water was used to extinguish the fires (i.e., AFFF was not used).	--	--	--	--	--	--	No	<p>TetraTech, 2011. Revised Final RCRA Partial Closure Report For Hangar 6 Aircraft Maintenance Hangar Parcel NAS Brunswick, ME. November 1, 2011. NIRIS #2528</p> <p>TetraTech, 2011. Addendum to RCRA Partial Closure Report For Hangar 6 Aircraft Maintenance Hangar Parcel NAS Brunswick, ME. December 1, 2011. NIRIS#2491</p> <p>Department of the Navy, 2010. Finding of Suitability to Transfer Airport Public Benefit Conveyance Parcel 1. December 2010. NIRIS #2143</p> <p>Lewis, Dave. Former Deputy Fire Chief for Naval Air Station Brunswick, Maine. Telephone interviews dated July 14, 2014 and August 13, 2014. Various email communications.</p>
Sites 1 & 3	Remediation activities at Site 11, the former Fire Training Area, included the removal of soils which were disposed of at the Sites 1 and 3 landfill.	--	--	--	--	--	--	Yes	OHM Remediation Services Corp., 1996. Remedial Action Final Report Remediation of Sites 1, 3, 5, 6 and 8, Naval Air Station Brunswick, Maine. August 8, 1996. NIRIS #562
Former Hangar 1	<p>Fire suppression system at the former Hangar 1 building was a water-based system.</p> <p>On June 13, 2007 a fire at Hangar 1 occurred when the hangar was being demolished. According to former staff, this fire was extinguished with water only (i.e., AFFF was not used).</p>	--	--	--	--	--	--	No	Lewis, Dave. Former Deputy Fire Chief for Naval Air Station Brunswick, Maine. Telephone interviews dated July 14, 2014 and August 13, 2014. Various email communications.
Former Hangar 2	Fire suppression system at the former Hangar 2 building was a water-based system.	--	--	--	--	--	--	No	Lewis, Dave. Former Deputy Fire Chief for Naval Air Station Brunswick, Maine. Telephone interviews dated July 14, 2014 and August 13, 2014. Various email communications.
Former Hangar 3	Fire suppression system at the former Hangar 3 building was a water-based system.	--	--	--	--	--	--	No	Lewis, Dave. Former Deputy Fire Chief for Naval Air Station Brunswick, Maine. Telephone interviews dated July 14, 2014 and August 13, 2014. Various email communications.
Hangar 4	<p>Based on information used to prepare the 2009 RCRA Tier II Report, Hangar 4 had two 2,000 gallon tanks of AFFF. These tanks are located in the northern portion of the Boiler House Building. The Boiler House Building is located adjacent to and on the northwest corner of Hangar 4.</p> <p>According to Dave Lewis, approximately 2 to 3 accidental releases of AFFF from the fire suppression system likely occurred at Hangar 4. Mr. McMahon recalls one significant release was triggered by motion of a computer screensaver.</p>	2	AST	2,000	5/28/1998	Unknown	According to the incident report, an accidental release of AFFF was triggered by a faulty alarm. Several gallons of AFFF spilled to the floor and saturating a GTC 85 (Huffer Unit). Cleanup included "pushing" the AFFF into the floor drainage system. The total quantitiy released was undertermined as most of the AFFF discharged to the floor drain.	Yes	<p>TetraTech, 2009. Backup Tier II Reporting Information for AFFF Quantities.</p> <p>TetraTech, 2011. Final RCRA Partial Closure Report for Building 250 Aircraft Intermediate Maintenance Division and Hangar 4 Aircraft Maintenance Hangar, NAS Brunwick, ME. May 1, 2011. NIRIS #2398</p> <p>McMahon, Marty. Former Program Manager for Fire and Emergency Response for Naval Air Station Brunswick, Maine. Personal interview. July 8, 2014.</p>
					12/17/2007	1,450	According to the incident report, the fire suppression system appears to have been manually activated. Approximately 1,400 gallons of AFFF mixed with 14,000 gallons of water was discharged inside the hangar and approximately 50 gallons of AFFF was discharged into the stormwater system outside the hangar.		<p>Lewis, Dave. Former Deputy Fire Chief for Naval Air Station Brunswick, Maine. Telephone interviews dated July 14, 2014 and August 13, 2014. Various email communications.</p> <p>Navy project files. File 7B2A, Brunswick Sewer District Correspondence. Incident report dated May 22, 1998 regarding Industrial Accident/AFFF in Drain at Hangar 4.</p> <p>Navy project files. File 7B2A, Brunswick Sewer District Correspondence. Incident report dated December 17, 2002 regarding release of AFFF from fire suppression system at Hangar 4.</p>

Table 10-1
Potential Aqueous Film-Forming Foam Source Areas
Perfluorinated Compounds in Groundwater
Sampling and Analysis Plan
Former Naval Air Station Brunswick
Brunswick, Maine

Location	AFFF Activity	Storage			Spills			Potential Source	Source
		Number of Containers	AST/Container	Capacity (Gallons)	Date	Amount (Gallons)	Details		
Hangar 5	Fire supression system that includes AFFF storage and nozzle dispensing system in the ceiling of the hangar bays. According to Dave Lewis, approximately 2 to 3 accidental releases of AFFF from the fire suppression system likely occurred at Hangar 5.	2	AST	1,100	8/14/2002	8,000 gallons of water/AFFF mix	During testing on the fire suppression system, AFFF was inadvertently released when the AFFF valve was not shut off. Approximately 8,000 gallons of water/foam was discharged to the hangar deck. The foam was so thick it drained out of the hangar building and into the storm drains since the hangar doors were left open. The foam was "pushed" back into the hangar and defoamer was used. The foam was observed in the stream behind the Galley [Outfall 09, The Galley]. On August 16 and 20, 2002, foam was still observed coming from the stormwater retention pond [Pond B] outfall [Outfall 03, Night Flight].	Yes	TetraTech, 2010. Final RCRA Partial Closure Report for Building 5 Hangar 5. May 14, 2010. NIRIS #2215 Department of the Navy, 2010. Finding of Suitability to Transfer Airport Public Benefit Conveyance Parcel 1. December 2010. NIRIS #2143 Lewis, Dave. Former Deputy Fire Chief for Naval Air Station Brunswick, Maine. Telephone interviews dated July 14, 2014 and August 13, 2014. Various email communications.
					10/25/2002	200-300	Leak occurred in Bay 3. Floodrains discharge to sanitary sewer. Anti-foaming agent applied to lift stations.		
		2	AST	600	5/25/2000	10 Gallon Solution/10 Gallon Concentrate	Release during annual maintenance testing of fire suppression system. Release to floor cleaned up and floor drains and sanitary lift station.		
Hangar 6	Fire supression system that includes AFFF storage and nozzle dispensing system in floor trenches of the hangar bays.	1	AST	2,500	Unknown	Unknown	According to Dave Lewis, approximately 2 to 3 accidental releases of AFFF from the fire suppression system likely occurred at Hangar 6. No documented release were available for Hangar 6.	Yes	TetraTech, 2011. Revised Final RCRA Partial Closure Report For Hangar 6 Aircraft Maintenance Hangar Parcel NAS Brunswick, ME. November 1, 2011. NIRIS #2528 TetraTech, 2011. Addendum to RCRA Partial Closure Report For Hangar 6 Aircraft Maintenance Hangar Parcel NAS Brunswick, ME. December 1, 2011. NIRIS#2491 Department of the Navy, 2010. Finding of Suitability to Transfer Airport Public Benefit Conveyance Parcel 1. December 2010. NIRIS #2143 Lewis, Dave. Former Deputy Fire Chief for Naval Air Station Brunswick, Maine. Telephone interviews dated July 14, 2014 and August 13, 2014. Various email communications.
Building 51 Naval Criminal Investigation Services (NCIS)/Fire Prevention Building	Building was used by NCIS and as a fire prevention office and storage area by the NAS Brunswick Fire Department for its entire history. No maintenance of fire equipment was conducted in the Fire Prevention garage. According to Dave Lewis, the former deputy fire chief, 5-gallon buckets were stored at Building 51 throughout the years.	27	Container	5	--	--	--	No	TetraTech, 2011. Final RCRA Partial Closure Report for Building 51 NAS Brunswick ME. January 21, 2011. NIRIS #2303 Lewis, Dave. Former Deputy Fire Chief for Naval Air Station Brunswick, Maine. Telephone interviews dated July 14, 2014 and August 13, 2014. Various email communications.
Building 81 Consolidated Hazardous Material Reutilization and Inventory Management Program (CHRIMP)	Fire supression system that includes AFFF storage and nozzle dispensing system in the ceiling and the shelving racks of the south (heated) storage area and in the ceiling of the north (cold) storage area. According to Dave Lewis, the former deputy fire chief, 5-gallon buckets were stored at Building 81 throughout the years.	2	AST	450	--	--	--	No	TetraTech, 2011. RCRA Partial Closure Report For Building 81 CHRIMP Facility Parcel NAS Brunswick, ME. July 1, 2011. NIRIS #2476 Department of the Navy, 2010. Finding of Suitability to Transfer Airport Public Benefit Conveyance Parcel 1. December 2010. NIRIS #2143 Lewis, Dave. Former Deputy Fire Chief for Naval Air Station Brunswick, Maine. Telephone interviews dated July 14, 2014 and August 13, 2014. Various email communications.
		Unknown	Container	5					
Building 252 Public Works Vehicle Maintenance Shop	Mechanical repairs to fire vehicles occurred at Building 252; however, this did not include repairs to the AFFF tanks/systems. During a repair effort, AFFF was observed to be leaking from the tank.	--	--	--	10/24/2002	20-30	Fire vehicle was leaking AFFF. The spill was contained and approximately 100 gallons of AFFF was drained from the tank; however, it was estimated that 20-30 gallons of AFFF discharged to the sanitary sewer system.	Yes	Navy project files. File 7B2A, Brunswick Sewer District Correspondence. Letter dated October 24, 2002 regarding AFFF Spill Building 252.
Building 292 Fire Department Building	Building 292 has functioned as the NAS Brunswick base fire station since its original construction in 1957. From 1990-2009, 9891 pounds of AFFF were used. Based on interviews with former staff, 5 fire vehicles were maintained at the fire department with AFFF tanks ranging from 50 to 160 gallons. Half of the total AFFF tank storage was required to be stored at Building 292, which was stored in 5-gallon buckets. Filling of the AFFF tanks was conducted at Building 292. Daily checks of the fire vehicles included water checks. Fire vehicles werre also washed on a daily and as needed basis.	Approximately 69	Container	5	Unknown	Unknown	Approximately 2-3 times a year, AFFF would accidentally be discharged during the daily water checks. In such instances, the truck would be flushed with approximately 3,000 gallons of water to clear out the hose line and dilute the foam discharge.	Yes	TetraTech, 2009. Backup Tier II Reporting Information for AFFF Quantities. TetraTech, 2011. Final RCRA Partial Closure Report for Building 292 Fire Department Building Parcel NAS Brunswick, ME. May 1, 2011. NIRIS #2488 TetraTech, 2011. Addendum to RCRA Partial Closure Report for Building 292 Fire Department Building Parcel NAS Brunswick, ME. December 1, 2011. NIRIS #2510 McMahon, Marty. Former Program Manager for Fire and Emergency Response for Naval Air Station Brunswick, Maine. Personal interview. July 8, 2014. Lewis, Dave. Former Deputy Fire Chief for Naval Air Station Brunswick, Maine. Telephone interviews dated July 14, 2014 and August 13, 2014. Various email communications.



Table 10-1
Potential Aqueous Film-Forming Foam Source Areas
Perfluorinated Compounds in Groundwater
Sampling and Analysis Plan
Former Naval Air Station Brunswick
Brunswick, Maine

Location	AFFF Activity	Storage			Spills			Potential Source	Source
		Number of Containers	AST/Container	Capacity (Gallons)	Date	Amount (Gallons)	Details		
Building 294 Supply Warehouse	<p>Based on information used to prepare the 2009 RCRA Tier II Report, Building 294 had 261 5-gallon containers of AFFF stored at the building. However, the 2010 RCRA Closure Report did not identify any AFFF being stored at the building.</p> <p>According to Dave Lewis, the former deputy fire chief, the backup load of AFFF required for the fire vehicles was stored in 5-gallon buckets at Building 294. The required backup volume was approximately 1,500 gallons.</p>	Approximately 300	Container	5	--	--	--	No	<p>TetraTech, 2009. Backup Tier II Reporting Information for AFFF Quantities.</p> <p>TetraTech, 2010. Final RCRA Partial Closure Report for Building 294 NAS Brunswick, ME. December 17, 2010. NIRIS #2281</p> <p>Lewis, Dave. Telephone interviews dated July 14, 2014 and August 13, 2014. Various email communications.</p>
Building 555 Sonobuoy/Vehicle Storage	<p>The southern part of the building was originally the sonobuoy shop but then more recently used as a storage area for the NAS Brunswick fire prevention department. Based on the 2011 RCRA Closure Report, a fire suppression system is noted in the northern portion of the building, but no AFFF was identified as being stored at the building.</p> <p>A soil and groundwater investigation conducted in November and December 2012 indicated that PFOS and PFOA were detected in soil below soil screening levels. Groundwater results indicated that PFOS was detected at concentrations above the USEPA PHA in wells MW-04S and MW-06S. PFOA was detected in groundwater below the USEPA PHA, but in well MW-04S, PFOA was detected at the same concentration as the MECDC MEG.</p>	Unknown	Container	5	10/5/2001	40	AFFF released to the oil/water separator and likely sanitary sewer system.	Yes	<p>TetraTech, 2011. RCRA Partial Closure Report For Building 555 Sonobuoy/Vehicle Storage Parcel NAS Brunswick, ME. April 1, 2011. NIRIS #2466</p> <p>TetraTech, 2013. Technical Memorandum Soil and Groundwater Investigation Building 611/555 Area, Former Naval Air Station Brunswick, Maine. April 22, 2013.</p>
Building 611 Aircraft Intermediate Maintenance Division (AIMD) Engine Test Cell	While there are no AFFF activities related to Building 611, this building is included due to its proximity to Building 555. Buildings 555 and 611 are being investigated together under separate cover.	--	--	--	--	--	--	No	TetraTech, 2011. Final RCRA Partial Closure Report for Building 611 NAS Brunswick, ME. April 6, 2011. NIRIS #2340
Building 653 Foam House	<p>Numerous buildings are part of the Jet Fuel Storage Installation (JFSI), including Building 653 which housed the emergency fire protection foam generation system.</p> <p>In June 2010, a site inspection of Building 653 indicated that the AST was empty and that there were no observed indications of past releases (e.g., staining) nor evidence of historic hazardous waste generation activities.</p>	1	AST	300	9/3/2004	10 Gallon Concentrate Mixed With Water	RCRA report indicates the spill occurred at the JFSI; however, no additional information was found in the MEDEP or NAS Brunswick spill records.	Yes	<p>TetraTech, 2010. Final RCRA Partial Closure Report for Buildings 56, 652, 653, 645, 655, and 656 NAS Brunswick, ME. October 1, 2010. NIRIS #2252</p> <p>Lewis, Dave. Former Deputy Fire Chief for Naval Air Station Brunswick, Maine. Telephone interviews dated July 14, 2014 and August 13, 2014. Various email communications.</p>
					Unknown	Unknown	According to Dave Lewis, the former deputy fire chief, at least one significant release of AFFF from the fire suppression occurred at Building 653 when it was triggered by a lightning strike.		
Grassy area west of Taxiway Alpha, west of Building 292	<p>Fire vehicle maintenance included fully dispensing the contents of the AFFF tanks for each fire vehicle two to three times a year. The dispensing process including mixing AFFF with water during the dispensing and continued until the contents of the tank were empty. This would use approximately 3,000 to 5,000 gallons of water to empty the contents of each of the AFFF tanks.</p>	--	--	--	Unknown	Unknown	Intentional releases of AFFF associated with fire vehicle operation and maintenance activities.	Yes	<p>Lewis, Dave. Former Deputy Fire Chief for Naval Air Station Brunswick, Maine. Telephone interviews dated July 14, 2014 and August 13, 2014. Various email communications.</p>
Wooded area south of Hangar 5 or in snow banks in this area during winter months									
Grassy area east of Hangar 5 and east of Taxiway Alpha									
Grassy area behind a house along perimeter road (which has since been demolished)									
Grassy area west of Admiral Fitch Avenue near the main entrance to the former NAS Brunswick base									
Grassy/wooded area past the paved area at the Red Label Area									

Notes:

AFFF - Aqueous Film-Forming Foam

NAS - Naval Air Station

NIRIS - Naval Installation Restoration Information Solution

PFC - Perfluorinated Compounds

RCRA - Resource Conservation and Recovery Act

**Table 11-1
Sampling Rationale
Perfluorinated Compounds in Groundwater
Sampling and Analysis Plan
Former Naval Air Station Brunswick
Brunswick, Maine**

Area	Proposed Groundwater Sample Location		Screened Interval (ft bgs) (Target Screen For Proposed Wells)	Screened Geologic Unit	Target Parameters		Rationale
					PFOS & PFOA ¹	PFCs ²	
Background	Single Well ³	NASB-BG-MW-01	12-22	Upper Sand	x	-	Characterize background PFC concentrations in shallow groundwater.
		NASB-BG-MW-02	12-17	Upper Sand			
		NASB-BG-MW-04	8-18	Upper Sand			
	Single Well ³	NASB-BG-MW-27	25-35	Upper Sand	x	-	
		NASB-BG-MW-28	25-35	Upper Sand			
	Single Well ³	NASB-BG-MW-18	3-8	Upper Sand	x	-	
		NASB-BG-MW-19	1.5-6.5	Upper Sand			
	Single Well ³	NASB-BG-MW-23	6-16	Transition	x	-	
		NASB-BG-MW-25	5-15	Transition			
Building 50 Groundwater Extraction Treatment System (GWETS)	Plant Influent		-	-	-	x	Determine the effectiveness of the GWETS on the treatment of various PFCs.
	HiPOx Effluent		-	-	-	x	
	Liquid GAC Mid-Treatment		-	-	-	x	
	Plant Effluent		-	-	-	x	
Site 11 Former Fire Training Area	MW-307		10-20	Upper Sand	x	-	Characterize PFC concentrations downgradient of Site 11. Site 11 was used for fire training for 30 years ending in 1990.
Sites 1 & 3 Landfill	MW-2101		Not Available	Not Available	x	-	Characterize PFC concentrations in the vicinity of Sites 1 & 3 based on placement of remediated soils from Site 11 into the landfill.
	MW-216A		18.5-28.5	Transition	x	-	
	MW-1&3-1301A		35-40	Not Available	x	-	
	MW-240		29-39	Transition	x	-	
Eastern Plume	MW-318		12-22	Upper Sand/Transition	x	-	Previous study showed PFCs in groundwater in the Eastern Plume. Define extent of PFCs that may extend beyond the defined limits of the Eastern Plume to aid in defining institutional controls.
	MW-337		75-85	Lower Sand	x	-	
	MW-NASB-212R		40-50	Transition	x	-	
Flightline ⁴ (Runway and Apron Areas)	PFC-MW-07 (Within Grassy Areas East of Runways)		TBD (Water Table)	-	x	-	Characterize PFC concentrations that may have entered groundwater from fire extinguishing activities that occurred on runways. In 1998, a release of AFFF occurred associated with a cockpit fire on the tarmac.
	PFC-MW-09 (Within Grassy Areas East of Runways)		TBD (Water Table)	-	x	-	
	PFC-MW-10 (Within Grassy Areas East of Runways)		TBD (Water Table)	-	x	-	
	PFC-MW-11 (Within Grassy Areas East of Runways)		TBD (Water Table)	-	x	-	

**Table 11-1
Sampling Rationale
Perfluorinated Compounds in Groundwater
Sampling and Analysis Plan
Former Naval Air Station Brunswick
Brunswick, Maine**

Area	Proposed Groundwater Sample Location	Screened Interval (ft bgs) (Target Screen For Proposed Wells)	Screened Geologic Unit	Target Parameters		Rationale
				PFOS & PFOA ¹	PFCs ²	
Hangar 4	<i>The following wells will be evaluated as part of the Eastern Flightline Investigation:</i> -MW-B250-01 -MW-B250-02 -MW-B250-04 -MW-B250-05 -MW-B250-13	See Eastern Flightline Area Groundwater Investigation Work Plan Dated July 17, 2014				Characterize PFC concentrations in the vicinity of Hangar 4 where reportedly 2-3 accidental releases of AFFF from the fire supression system occurred.
Hangar 5	MW-09-001	30-40	Lower Sand	x	-	Characterize PFC concentrations downgradient of Hangar 5 and in vicinity of the sanitary sewer system. Hangar 5 has AFFF stored in above ground storage tanks and had at least three releases of AFFF in 1998, 2000, and 2002. In addition, runoff from runways and support building drains to rear of Hangar 5.
	MW-NASB-227	27-37	Lower Sand	x	-	
	PFC-MW-15 (Off North East Corner of Hangar)	TBD (Water Table)	-	x	-	
	PFC-MW-14 (East of Hangar, Between Central and Southern Portion of Hangar)	TBD (Water Table)	-	x	-	
Hangar 6 ⁴	NASB-H123-MW10	3.2-8.2	Upper Sand	x	-	Characterize PFC concentrations in the vicinity of Hangar 6 where reportedly 2-3 accidental releases of AFFF from the fire supression system occurred.
	PFC-MW-06 (Within the grassy area downgradient (north) of Hangar 6)	TBD (Water Table)	-	x	-	
	PFC-MW-05 (Within the grassy/wooded area downgradient (north) of Hangar 6 near stream)	TBD (Water Table)	-	x	-	
Building 252 Public Works Vehicle Maintenance Shop	B225-MW09	5-15	Upper Sand/Transition	x	-	Characterize PFC concentrations in the vicinity of Building 252 where a reported accidental release of AFFF from a fire crash vehicle occurred.
Building 292 Fire Department	<i>The following well will be evaluated as part of the Eastern Flightline Investigation:</i> -EFA-08	See Eastern Flightline Area Groundwater Investigation Work Plan Dated July 17, 2014				Characterize PFC concentrations in the vicinity of the Fire Department (Building 292).
Building 555 (Sonobuoy/Vehicle Storage) and Building 611 (Aircraft Intermediate Maintenance Division (AIMD) Engine Test Cell	B611-MW04S	8-18	Upper Sand	x	-	Re-sampling of PFCs detected in these wells based on December 2012 groundwater investigation. Re-sampling of wells will provide PFC concentrations in this area between Hangar 5 and Sites 1 & 3.
	B611-MW06S	8-18	Upper Sand	x	-	

**Table 11-1
Sampling Rationale
Perfluorinated Compounds in Groundwater
Sampling and Analysis Plan
Former Naval Air Station Brunswick
Brunswick, Maine**

Area	Proposed Groundwater Sample Location	Screened Interval (ft bgs) (Target Screen For Proposed Wells)	Screened Geologic Unit	Target Parameters		Rationale
				PFOS & PFOA ¹	PFCs ²	
Building 653 Foam House	PFC-MW-03 (Within the grassy area immediately downgradient of Building 653)	TBD (Water Table)	-	x	-	Characterize PFC concentrations in the vicinity of Building 653 (Foam House) where reportedly 2-3 accidental releases of AFFF from the fire suppression system occurred.
	PFC-MW-04 (Within the grassy area downgradient of Building 653)	TBD (Water Table)	-	x	-	
	MW-801	2-7	Not Available	x	-	
AFFF Discharge Areas ⁴	PFC-MW-08 (Within the grassy area west of taxiway Alpha, west of Building 292)	TBD (Water Table)	-	x	-	Characterize PFC concentrations at locations where AFFF was discharged from fire vehicles.
	PFC-MW-13 (Within the wooded area south of Hangar 5)	TBD (Water Table)	-	x	-	
	PFC-MW-12 (Within the grassy area west of Hangar 5 and east of taxiway Alpha)	TBD (Water Table)	-	x	-	
	PFC-MW-01 (Within the grassy area behind a demolished house along perimeter road)	TBD (Water Table)	-	x	-	
	PFC-MW-02 (Within the grassy area west of Admiral Fitch Avenue near the main entrance to the former NAS Brunswick base)	TBD (Water Table)	-	x	-	
	PFC-MW-17 (Within the grassy/wooded area west of the paved area at the Red Label Area)	TBD (Water Table)	-	x	-	
	PFC-MW-16 (Within the grassy/wooded area south of the paved area at the Red Label Area)	TBD (Water Table)	-	x	-	

Notes:

1 - PFOS = perfluorooctane sulfonate and PFOA = perfluorooctanoic acid.

2 - A total of 16 PFCs will be analyzed from samples collected from the GWETS. Refer to Worksheet #15 in the SAP for the full list of PFCs to be analyzed.

3 - A single well for each group of wells listed will be chosen in the field based on accessibility and well conditions. Refer to Section 17.4 in Worksheet 17 of the SAP for specific details.

4 - New proposed well locations to be determined based on field conditions such as accessibility and drainage patterns.

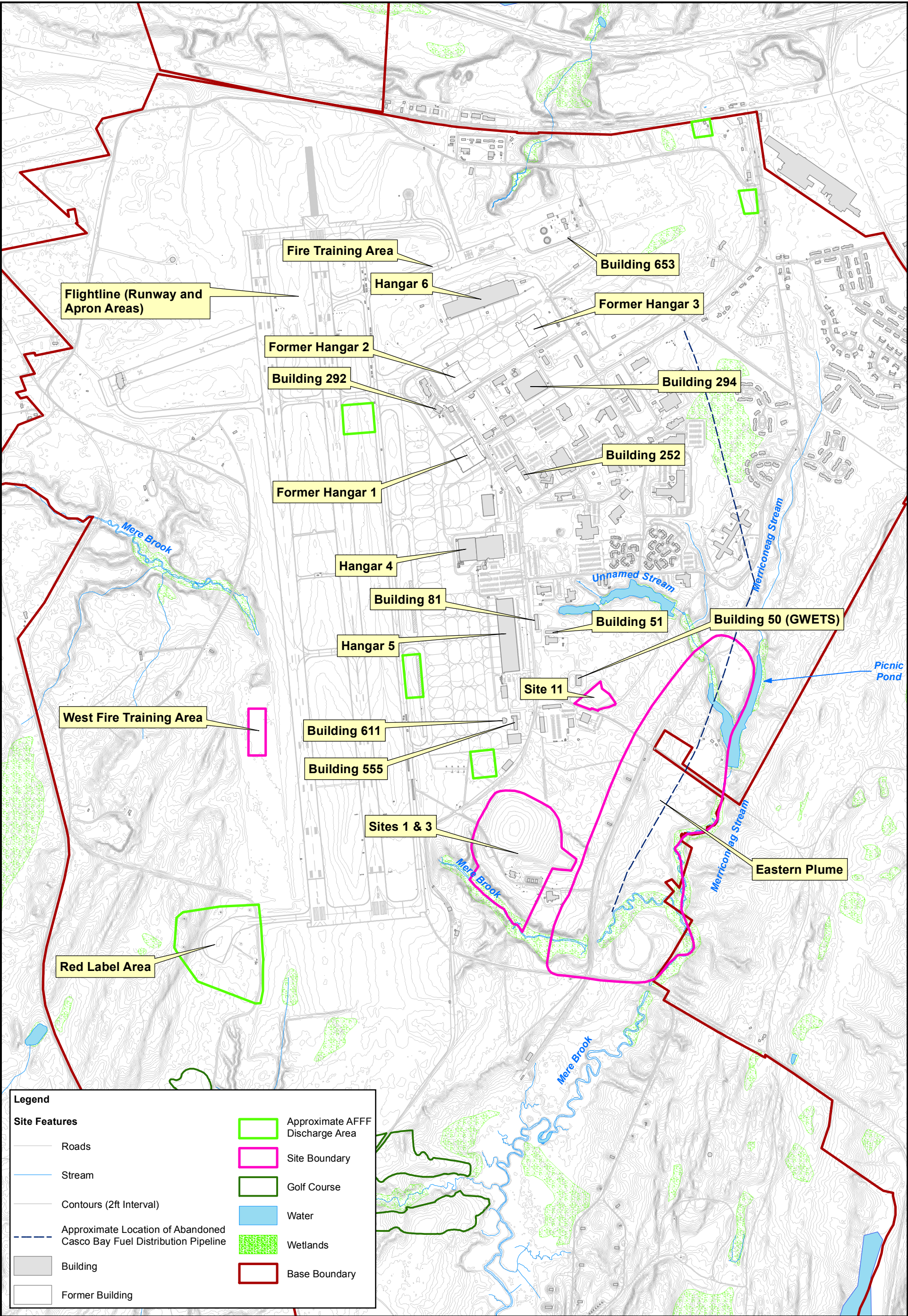
AFFF - Aqueous film-forming foam.


ft bgs - Feet below the ground surface.

PFC - Perfluorinated compounds.

TBD - To be determined.

Figures






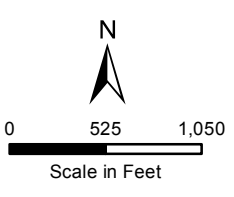
Drawn: JEB 10/09/2014

Approved: CD 10/09/2014

Project #: 60271305

Map Location





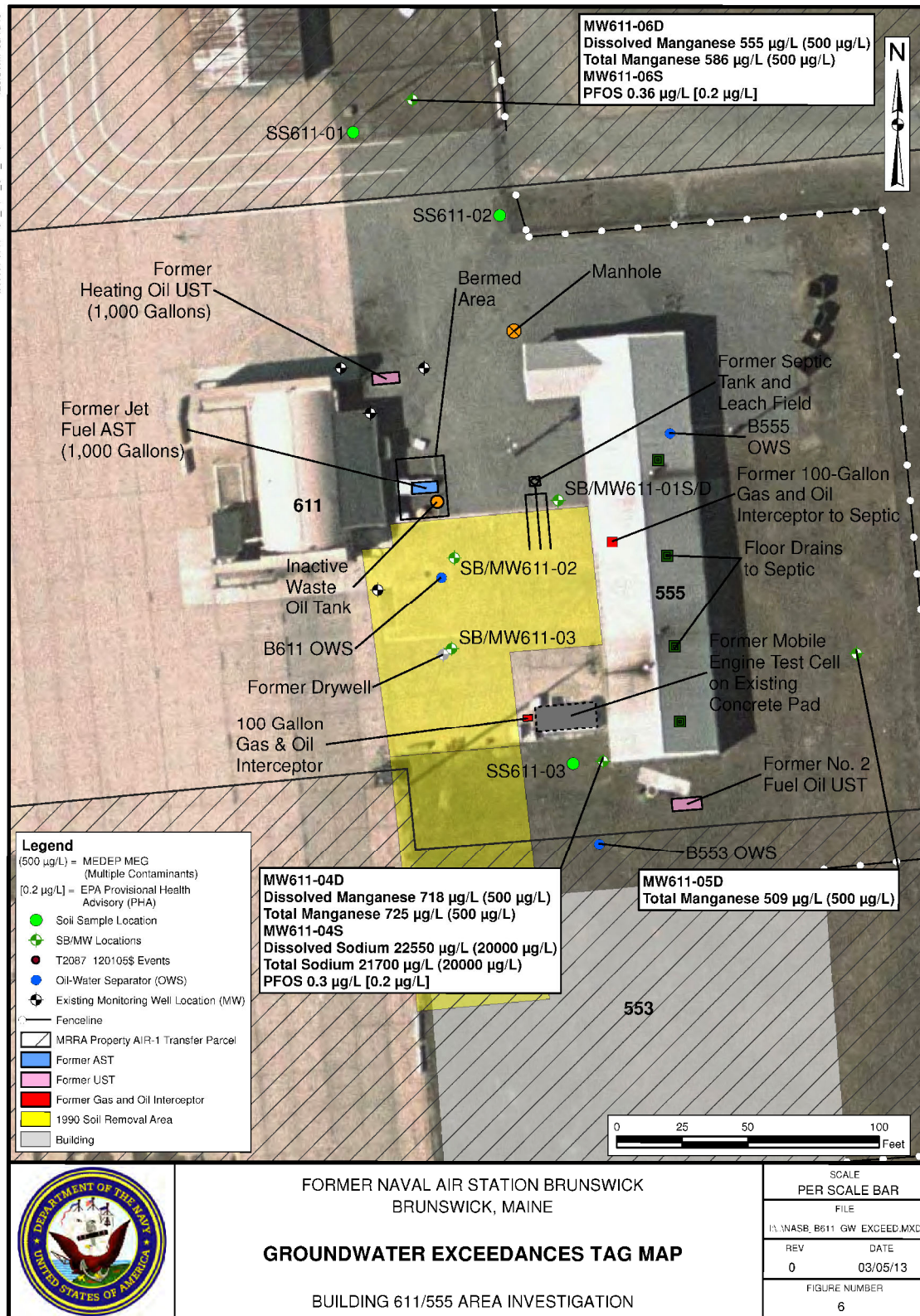
0 525 1,050

Scale in Feet

FIGURE 10-1
POTENTIAL SOURCE AREA LOCATION MAP
SAMPLING AND ANALYSIS PLAN

FORMER NAVAL AIR STATION BRUNSWICK
BRUNSWICK, MAINE

I:\00568100\NASB_B611_GW_EXCEED.MXD NEC:DWI 03/15/13



Drawn: JB 10/09/2014

Approved: CD 10/09/2014

Project #: 60271305

Map Location

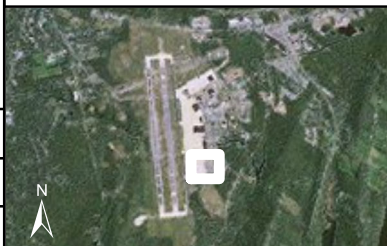
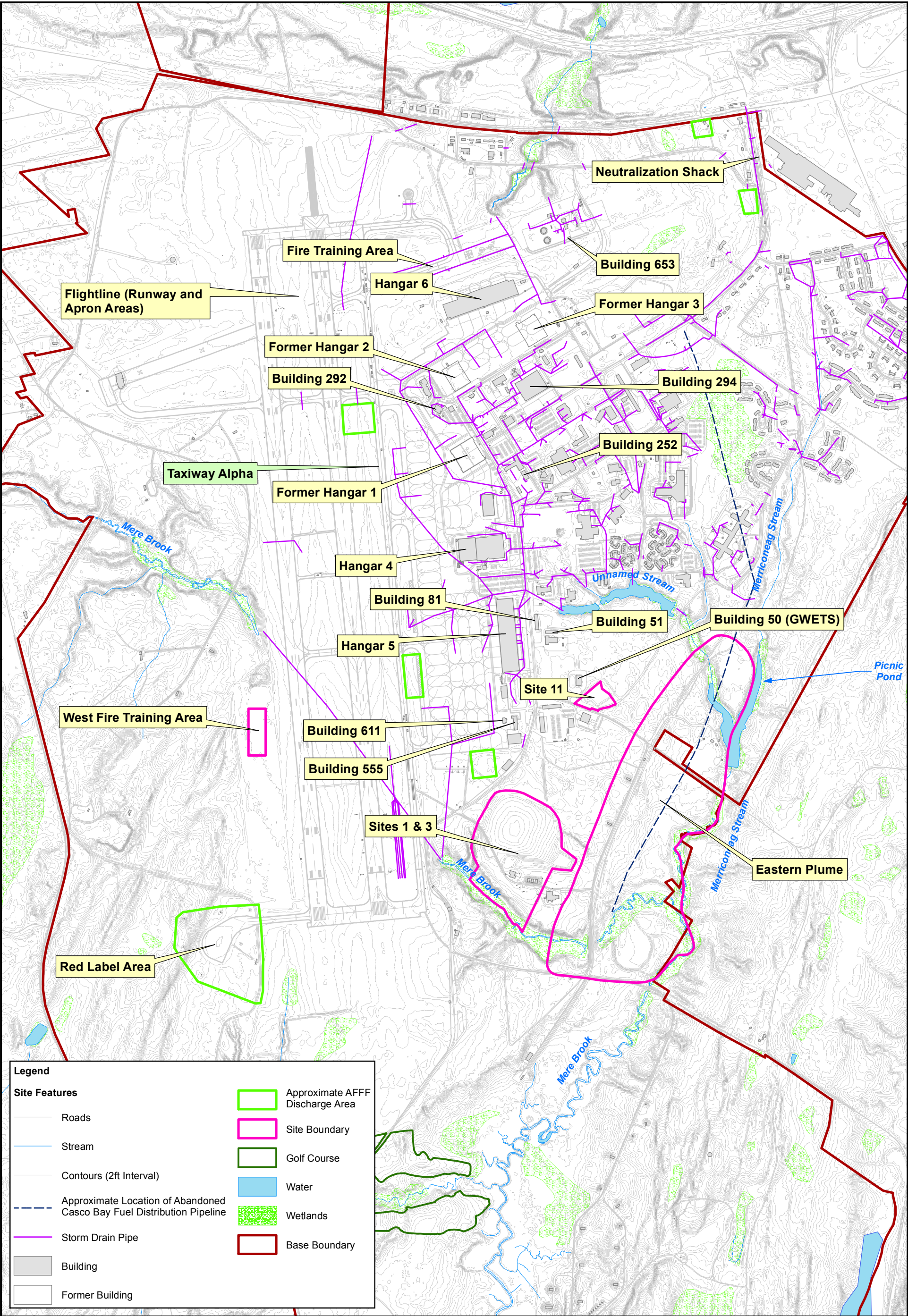


FIGURE 10-3 PERFLUORINATED COMPOUNDS SAMPLING RESULTS BUILDING 611/555 AREA SAMPLING AND ANALYSIS PLAN

FORMER NAVAL AIR STATION BRUNSWICK
BRUNSWICK, MAINE



RESOLUTION CONSULTANTS

Drawn: JEB 10/09/2014

Approved: CD 10/09/2014

Project #: 60271305

Map Location

N

0 525 1,050

Scale in Feet

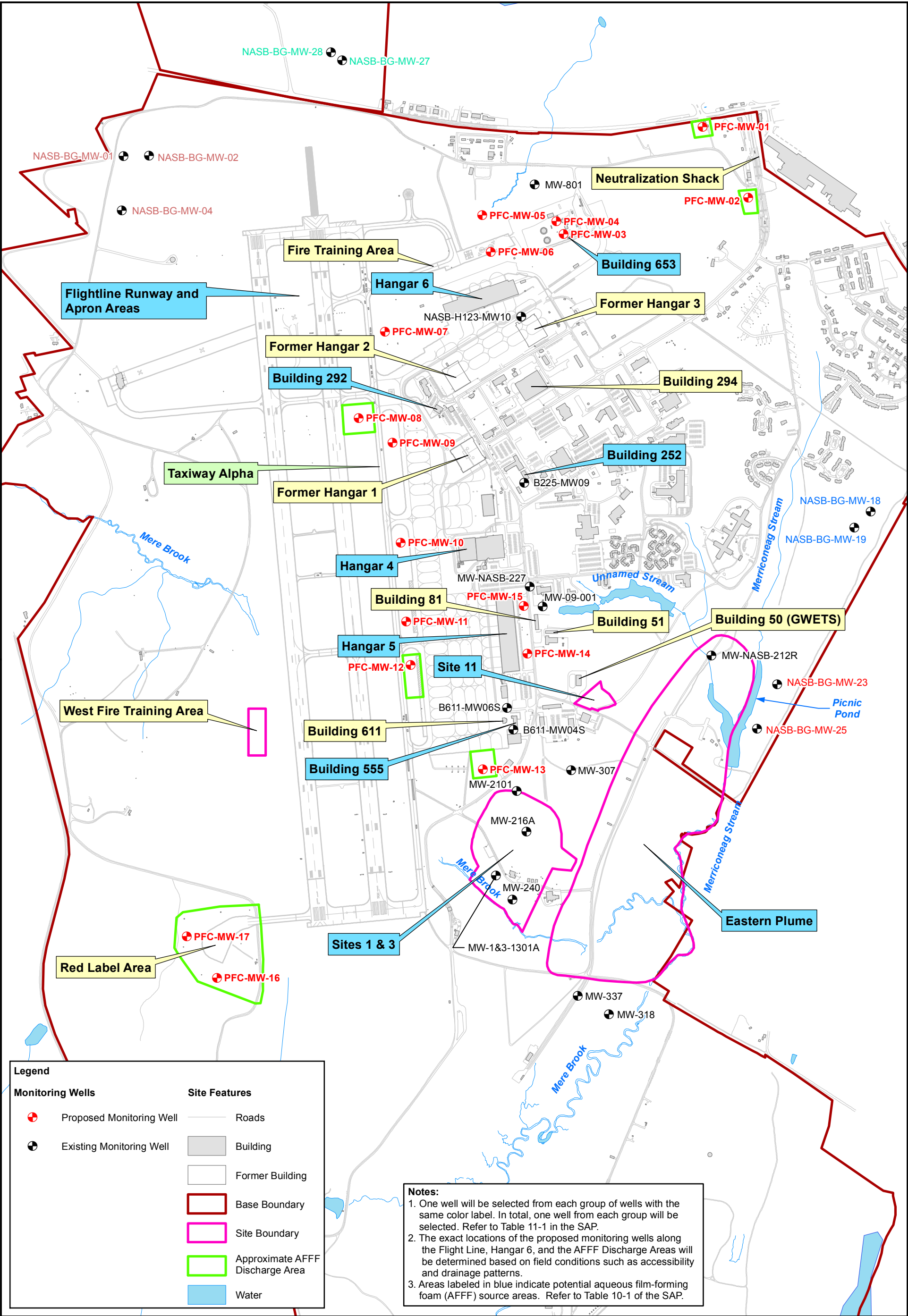
FIGURE 10-4

HISTORIC AFFF SITE OPERATIONS

SAMPLING AND ANALYSIS PLAN

FORMER NAVAL AIR STATION BRUNSWICK

BRUNSWICK, MAINE



Drawn: JEB 10/09/2014

Approved: CD 10/09/2014

Project #: 60271305

Map Location

N

0 525 1,050

Scale in Feet

FIGURE 11-1

PROPOSED GROUNDWATER SAMPLE LOCATIONS

SAMPLING AND ANALYSIS PLAN

FORMER NAVAL AIR STATION BRUNSWICK

BRUNSWICK, MAINE

Appendix A

Standard Operating Procedures

Utility Clearance

Procedure 3-01

1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the process for determining the presence of subsurface utilities and other cultural features at locations where planned site activities involve the physical disturbance of subsurface materials.
- 1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).
- 1.3 The procedure applies to the following activities: soil gas surveying, excavating, trenching, drilling of borings and installation of monitoring and extraction wells, use of soil recovery or slide-hammer hand augers, and all other intrusive sampling activities.
- 1.4 The primary purpose of the procedure is to minimize the potential for damage to underground utilities and other subsurface features, which could result in physical injury, disruption of utility service, or disturbance of other subsurface cultural features.
- 1.5 If there are procedures, whether it be from Resolution Consultants, state, and/or federal, that are not addressed in this SOP and are applicable to utility clearance, those procedures should be added as an appendix to the project specific SAP.
- 1.6 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

- 2.1 Field and subcontractor personnel shall adhere to a site-specific health and safety plan (HASP).

3.0 Terms and Definitions

3.1 Utility

For the purposes of this SOP, a utility is defined as a manmade underground line or conduit, cable, pipe, vault or tank that is, or was, used for the transmission of material or energy (e.g., gas, electrical, telephone, steam, water or sewage, product transfer lines, or underground storage tanks).

3.2 As-Built Plans

As-built plans are plans or blueprints depicting the locations of structures and associated utilities on a property.

3.3 One-Call

The Utility Notification Center is the one-call agency for nationwide call before you dig. The Utility Notification Center is open 24 hours a day, and accepts calls from anyone planning to dig. The phone number 811 is the designated call before you dig phone number that directly connects you to your local one-call center. Additional information can be found at www.call811.com.

Calling before you dig ensures that any publicly owned underground lines will be marked so that you can dig around them safely. Having the utility lines marked not only prevents accidental damage to the lines, but prevents property damage and personal injuries that could result in breaking a line.

The following information will need to be provided when a call is placed to One-Call:

- Your name, phone number, company name (if applicable), and mailing address.
- What type of work is being done.
- Who the work is being done for.
- The county and city the work is taking place in.
- The address or the street where the work is taking place.
- Marking instructions, (specific instructions as to where the work is taking place).

Under normal circumstances it takes between 2 to 5 days from the time you call (not counting weekends or holidays) to have the underground lines marked. Because these laws vary from state to state, exactly how long it will take depends on where your worksite is located. You will be given an exact start time and date when your locate request is completed, which will comply with the laws in your area.

In the event of an emergency (any situation causing damage to life or property, or a service outage), lines can be marked sooner than the original given time if requested.

3.4 Toning

Toning is the process of surveying an area utilizing one or more surface geophysical methods to determine the presence or absence of underground utilities. Typically, toning is conducted after identifying the general location of utilities and carefully examining all available site utility plans. Each location is marked according to the type of utility being identified. In addition, areas cleared by toning are flagged or staked to indicate that all identified utilities in a given area have been toned.

4.0 Training and Qualifications

- 4.1 The **Contract Task Order (CTO) Manager** is responsible for verifying that these utility locating procedures are performed prior to the initiation of active subsurface exploration.
- 4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 4.3 The **Field Manager** is responsible for ensuring that all utility locating activities are performed in accordance with this procedure.
- 4.4 All **Field Personnel** are responsible for the implementation of this procedure.

5.0 Equipment and Supplies

- 5.1 Equipment and supplies necessary for locating subsurface utilities will be provided by the subcontractor; however, the project **Field Manager/Field Personnel** will provide any additional equipment and supplies as needed as well as maintain information regarding the utility clearance activities in the field logbook.

6.0 Procedure

Proceed with the following steps where subsurface exploration will include excavations, drilling, or any other subsurface investigative method that could damage utilities at a site. In addition to the steps outlined below, always exercise caution while conducting subsurface exploratory work.

6.1 **Prepare Preliminary Site Plan**

- Prepare a preliminary, scaled site plan depicting the proposed exploratory locations as part of the project specific Sampling and Analysis Plan (SAP) or Work Plan. Include as many of the cultural and natural features as practical in this plan.

6.2 **Review Background Information**

- Search existing plan files to review the as-built plans to identify the known location of utilities at the site. Plot the locations of utilities identified onto a preliminary, scaled site plan. Inform the CTO Manager if utilities lie within close proximity to a proposed exploration or excavation location. The CTO Manager will determine if it is necessary to relocate proposed sampling or excavation locations.
- Include the utility location information gathered during previous investigations (e.g., remedial investigation or remedial site evaluation) in the project design documents for removal or remedial actions. In this manner, information regarding utility locations collected during implementation of a CTO can be shared with the subcontractor during implementation of a particular task order. In many instances, this will help to reduce the amount of additional geophysical surveying work the subcontractor may have to perform.
- Conduct interviews with onsite and facility personnel familiar with the site to obtain additional information regarding the known and suspected locations of underground utilities. In addition, if appropriate, contact shall be made with local utility companies to request their help in locating underground lines. Pencil in the dimensions, orientation, and depth of utilities, other than those identified on the as-built plans, at their approximate locations on the preliminary plans. Enter the type of utility, the personnel who provided the information, and the date the information was provided into the field log.
- During the pre-field work interviewing process, the interviewer will determine which site personnel should be notified in the event of an incident involving damage to existing utilities. Record this information in the field logbook with the corresponding telephone numbers and addresses.

6.3 **Site Visit/Locate Utilities/Toning**

- Prior to the initiation of field activities, the Field Task Manager or similarly qualified field personnel shall visit the site and note existing structures and evidence of associated utilities, such as fire hydrants, irrigation systems, manhole and vault box covers, standpipes, telephone switch boxes, free-standing light poles, gas or electric meters, pavement cuts, and linear depression. Compare notes of the actual site configuration to the preliminary site plan. Note deviations in the field logbook and on the preliminary site plan. Accurately locate or survey and clearly mark with stakes, pins, flags, paint, or other suitable devices all areas where subsurface exploration is proposed. These areas shall correspond with the locations drawn on the preliminary site plan.
- Following the initial site visit by the Field Task Manager, a trained utility locating subcontractor will locate, identify, and tone all utilities depicted on the preliminary site plan. The Field Task Manager or similarly qualified field personnel shall visit the site and identify the areas of subsurface disturbance with white spray paint, chalk, white pin flags or some other easily identifiable marking. The utility locator should utilize appropriate sensing equipment to attempt to locate utilities that might not have appeared on the as-built plans. At a minimum, the utility subcontractor should utilize a metal detector and/or magnetometer; however, it is important to consider the possibility that non-metallic utilities or tanks might be present at the site. Use other appropriate surface geophysical methods such as Ground Penetrating Radar, Radiodetection, etc. as appropriate. Clear proposed exploration areas of all utilities in the immediate area where subsurface exploration is proposed. Clearly tone all anomalous areas. Clearly identify all toned areas on the preliminary site plan. All utilities near the area of subsurface disturbance should also be marked out by the utility subcontractor using the universal colors for subsurface utilities (i.e., red – electric; blue – water; green – sewer; yellow – gas; etc.). After toning the site and plotting all known or suspected buried utilities on the preliminary site plan, the utility locator shall provide the Field Task Manager with a copy of the completed preliminary

site plan. Alternatively, the Field Task Manager or designee shall document the results of the survey on the preliminary site plan.

- Report to the Field Task Manager anomalous areas detected and toned that are in close proximity to the exploration or excavation areas. The Field Task Manager shall determine the safe distance to maintain from the known or suspected utility. It may be necessary to relocate the proposed exploration or excavation areas. If this is required, the Field Task Manager or designee shall relocate them and clearly mark them using the methods described above. Completely remove the markings at the prior location. Plot the new locations on the site plan and delete the prior locations from the plan. In some instances, such as in areas extremely congested with subsurface utilities, it may be necessary to dig by hand or use techniques such as air knife to determine the location of the utilities.

6.4 **Prepare Site Plan**

- Prior to the initiation of field activities, draft a final site plan that indicates the location of subsurface exploration areas and all known or suspected utilities present at the site. Provide copies of this site plan to the Navy Technical Representative (NTR), the CTO Manager, and the subcontractor who is to conduct the subsurface exploration/excavation work. Review the site plan with the NTR to verify its accuracy prior to initiating subsurface sampling activities.

7.0 **Quality Control and Assurance**

- 7.1 Utility locating must incorporate quality control measures to ensure conformance to these and the project requirements.

8.0 **Records, Data Analysis, Calculations**

- 8.1 A bound field logbook will be kept detailing all activities conducted during the utility locating procedure.
- 8.2 The logbook will describe any changes and modifications made to the original exploration plan. The trained utility locator shall prepare a report and keep it in the project file. Also, a copy of the final site plan will be kept in the project file.

9.0 **Attachments or References**

Department of Defense, United States (DoD). 2005. [Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual](http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf). Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Author	Reviewer	Revisions (Technical or Editorial)
Caryn DeJesus Senior Scientist	Bob Shoemaker Senior Scientist	Rev 0 – Initial Issue (June 2012)

Logbooks

Procedure 3-02

1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the activities and responsibilities pertaining to the identification, use, and control of logbooks and associated field data records.
- 1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

- 2.1 In order to keep the logbook clean, store it in a clean location and use it only when outer gloves used for PPE have been removed.

3.0 Terms and Definitions

3.1 Logbook

A logbook is a bound field notebook with consecutively numbered, water-repellent pages that is clearly identified with the name of the relevant activity, the person assigned responsibility for maintenance of the logbook, and the beginning and ending dates of the entries.

3.2 Data Form

A data form is a predetermined format utilized for recording field data that may become, by reference, a part of the logbook (e.g., soil boring logs, trenching logs, surface soil sampling logs, groundwater sample logs, and well construction logs are data forms).

4.0 Training and Qualifications

- 4.1 The **Contract Task Order (CTO) Manager** or **designee** is responsible for determining which team members shall record information in field logbooks and for obtaining and maintaining control of the required logbooks. The **CTO Manager** shall review the field logbook on at least a monthly basis. The **CTO Manager** or **designee** is responsible for reviewing logbook entries to determine compliance with this procedure and to ensure that the entries meet the project requirements.
- 4.2 A knowledgeable individual such as the **Field Manager**, **CTO Manager**, or **Program Quality Manager** shall perform a technical review of each logbook at a frequency commensurate with the level of activity (weekly is suggested, or, at a minimum, monthly). Document these reviews by the dated signature of the reviewer on the last page or page immediately following the material reviewed.
- 4.3 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 4.4 The **Field Manager** is responsible for ensuring that all **field personnel** follow these procedures and that the logbook is completed properly and daily. The **Field Manager** is also responsible for submitting copies to the **CTO Manager**, who is responsible for filing them and submitting a copy (if required by the CTO Statement of Work).
- 4.5 The **logbook user** is responsible for recording pertinent data into the logbook to satisfy project requirements and for attesting to the accuracy of the entries by dated signature. The **logbook user** is also responsible for safeguarding the logbook while having custody of it.

4.6 All **field personnel** are responsible for the implementation of this procedure.

5.0 Equipment and Supplies

5.1 Field logbooks shall be bound field notebooks with water-repellent pages.

5.2 Pens shall have indelible black ink.

6.0 Procedure

6.1 The field logbook serves as the primary record of field activities. Make entries chronologically and in sufficient detail to allow the writer or a knowledgeable reviewer to reconstruct the applicable events. Store the logbook in a clean location and use it only when outer gloves used for personal protective equipment (PPE) have been removed.

6.2 Individual data forms may be generated to provide systematic data collection documentation. Entries on these forms shall meet the same requirements as entries in the logbook and shall be referenced in the applicable logbook entry. Individual data forms shall reference the applicable logbook and page number. At a minimum, include names of all samples collected in the logbook even if they are recorded elsewhere.

6.3 Enter field descriptions and observations into the logbook, as described in Attachment 1, using indelible black ink.

6.4 Typical information to be entered includes the following:

- Dates (month/day/year) and times (military) of all on-site activities and entries made in logbooks/forms;
- Site name and description;
- Site location by longitude and latitude, if known;
- Weather conditions, including temperature and relative humidity;
- Fieldwork documentation, including site entry and exit times;
- Descriptions of, and rationale for, approved deviations from the work plan (WP) or field sampling plan;
- Field instrumentation readings;
- Names, job functions, and organizational affiliations of on-site personnel;
- Photograph references;
- Site sketches and diagrams made on site;
- Identification and description of sample morphology, collection locations, and sample numbers;
- Sample collection information, including dates (month/day/year) and times (military) of sample collections, sample collection methods and devices, station location numbers, sample collection depths/heights, sample preservation information, sample pH (if applicable), analysis requested (analytical groups), etc., as well as chain-of-custody (COC) information such as sample identification numbers cross-referenced to COC sample numbers;
- Sample naming convention;
- Field quality control (QC) sample information;
- Site observations, field descriptions, equipment used, and field activities accomplished to reconstruct field operations;

- Meeting information;
 - Important times and dates of telephone conversations, correspondence, or deliverables;
 - Field calculations;
 - PPE level;
 - Calibration records;
 - Contractor and subcontractor information (address, names of personnel, job functions, organizational affiliations, contract number, contract name, and work assignment number);
 - Equipment decontamination procedures and effectiveness;
 - Laboratories receiving samples and shipping information, such as carrier, shipment time, number of sample containers shipped, and analyses requested; and
 - User signatures.
- 6.5 The logbook shall reference data maintained in other logs, forms, etc. Correct entry errors by drawing a single line through the incorrect entry, then initialing and dating this change. Enter an explanation for the correction if the correction is more than for a mistake.
- 6.6 At least at the end of each day, the person making the entry shall sign or initial each entry or group of entries.
- 6.7 Enter logbook page numbers on each page to facilitate identification of photocopies.
- 6.8 If a person's initials are used for identification, or if uncommon acronyms are used, identify these on a page at the beginning of the logbook.
- 6.9 At least weekly and preferably daily, the **preparer** shall photocopy and retain the pages completed during that session for backup. This will prevent loss of a large amount of information if the logbook is lost.

7.0 Quality Control and Assurance

- 7.1 Review per Section 4.2 shall be recorded.

8.0 Records, Data Analysis, Calculations

- 8.1 Retain the field logbook as a permanent project record. If a particular CTO requires submittal of photocopies of logbooks, perform this as required.
- 8.2 Deviations from this procedure shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

9.0 Attachments or References

- 9.1 Attachment 1 – Description of Logbook Entries
- 9.2 Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue

Attachment 1

Description of Logbook Entries

Logbook entries shall be consistent with Section A.1.4 *Field Documentation SOPs* of the UFP-QAPP Manual (DoD 2005) and contain the following information, as applicable, for each activity recorded. Some of these details may be entered on data forms, as described previously.

Name of Activity	For example, Asbestos Bulk Sampling, Charcoal Canister Sampling, Aquifer Testing.
Task Team Members and Equipment	Name all members on the field team involved in the specified activity. List equipment used by serial number or other unique identification, including calibration information.
Activity Location	Indicate location of sampling area as indicated in the field sampling plan.
Weather	Indicate general weather and precipitation conditions.
Level of PPE	Record the level of PPE (e.g., Level D).
Methods	Indicate method or procedure number employed for the activity.
Sample Numbers	Indicate the unique numbers associated with the physical samples. Identify QC samples.
Sample Type and Volume	Indicate the medium, container type, preservative, and the volume for each sample.
Time and Date	Record the time and date when the activity was performed (e.g., 0830/08/OCT/89). Use the 24-hour clock for recording the time and two digits for recording the day of the month and the year.
Analyses	Indicate the appropriate code for analyses to be performed on each sample, as specified in the WP.
Field Measurements	Indicate measurements and field instrument readings taken during the activity.
Chain of Custody and Distribution	Indicate chain-of-custody for each sample collected and indicate to whom the samples are transferred and the destination.
References	If appropriate, indicate references to other logs or forms, drawings, or photographs employed in the activity.
Narrative (including time and location)	Create a factual, chronological record of the team's activities throughout the day including the time and location of each activity. Include descriptions of general problems encountered and their resolution. Provide the names and affiliations of non-field team personnel who visit the site, request changes in activity, impact the work schedule, request information, or observe team activities. Record any visual or other observations relevant to the activity, the contamination source, or the sample itself. It should be emphasized that logbook entries are for recording data and chronologies of events. The logbook author must include observations and descriptive notations, taking care to be objective and recording no opinions or subjective comments unless appropriate.
Recorded by	Include the signature of the individual responsible for the entries contained in the logbook and referenced forms.
Checked by	Include the signature of the individual who performs the review of the completed entries.

Recordkeeping, Sample Labeling, and Chain-of-Custody

Procedure 3-03

1.0 Purpose and Scope

- 1.1 The purpose of this standard operating procedure is to establish standard protocols for all field personnel for use in maintaining field and sampling activity records, writing sample logs, labeling samples, ensuring that proper sample custody procedures are utilized, and completing chain-of-custody/analytical request forms.
- 1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

Not applicable.

3.0 Terms and Definitions

3.1 Logbook

A logbook is a bound field notebook with consecutively numbered, water-repellent pages that is clearly identified with the name of the relevant activity, the person responsible for maintenance of the logbook, and the beginning and ending dates of the entries.

3.2 Chain-of-Custody

Chain-of-custody (COC) is documentation of the process of custody control. Custody control includes possession of a sample from the time of its collection in the field to its receipt by the analytical laboratory, and through analysis and storage prior to disposal.

4.0 Training and Qualifications

- 4.1 The **CTO Manager** is responsible for determining which team members shall record information in the field logbook and for checking sample logbooks and COC forms to ensure compliance with these procedures. The **CTO Manager** shall review COC forms on a monthly basis at a minimum.
- 4.2 The **CTO Manager** and **Program Quality Manager** are responsible for evaluating project compliance with the Project Procedures Manual.
- 4.3 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 4.4 The **Laboratory Project Manager** or **Sample Control Department Manager** is responsible for reporting any sample documentation or COC problems to the **CTO Manager** or **CTO Laboratory Coordinator** within 24 hours of sample receipt.
- 4.5 The **Field Manager** is responsible for ensuring that all **field personnel** follow these procedures. The **CTO Laboratory Coordinator** is responsible for verifying that the COC/analytical request forms have been completed properly and match the sampling and analysis plan. The **CTO Manager** or **CTO Laboratory Coordinator** is responsible for notifying the **laboratory, data managers, and data validators** in writing if analytical request changes are required as a corrective action. These small changes are different from change orders, which involve changes to the scope of the subcontract with

the laboratory and must be made in accordance with a respective contract (e.g., CLEAN remedial action contract).

- 4.6 All **field personnel** are responsible for following these procedures while conducting sampling activities. **Field personnel** are responsible for recording pertinent data into the logbook to satisfy project requirements and for attesting to the accuracy of the entries by dated signature.

5.0 Procedure

This procedure provides standards for documenting field activities, labeling the samples, documenting sample custody, and completing COC/analytical request forms. The standards presented in this section shall be followed to ensure that samples collected are maintained for their intended purpose and that the conditions encountered during field activities are documented.

5.1 Recordkeeping

The field logbook serves as the primary record of field activities. Make entries chronologically and in sufficient detail to allow the writer or a knowledgeable reviewer to reconstruct each day's events. Field logs such as soil boring logs and ground-water sampling logs will also be used. These procedures are described in Procedure 3-02, *Logbooks*.

5.2 Sample Labeling

Affix a sample label with adhesive backing to each individual sample container. Place clear tape over each label (preferably prior to sampling) to prevent the labels from tearing off, falling off, being smeared, and to prevent loss of information on the label. Record the following information with a waterproof marker on each label:

- Project name or number (optional);
- COC sample number;
- Date and time of collection;
- Sampler's initials;
- Matrix (optional);
- Sample preservatives (if applicable); and
- Analysis to be performed on sample (this shall be identified by the method number or name identified in the subcontract with the laboratory).

These labels may be obtained from the analytical laboratory or printed from a computer file onto adhesive labels.

5.3 Custody Procedures

For samples intended for chemical analysis, sample custody procedures shall be followed through collection, transfer, analysis, and disposal to ensure that the integrity of the samples is maintained. Maintain custody of samples in accordance with the U.S. Environmental Protection Agency (EPA) COC guidelines prescribed in EPA *NEIC Policies and Procedures*, National Enforcement Investigations Center, Denver, Colorado, revised May 1986; EPA *RCRA Ground Water Monitoring Technical Enforcement Guidance Document* (TEGD); *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA OSWER Directive 9355 3-01); Appendix 2 of the *Technical Guidance Manual for Solid Waste Water Quality Assessment Test (SWAT) Proposals and Reports*; and *Test Methods for Evaluating Solid Waste* (EPA SW-846)

A description of sample custody procedures is provided below.

5.3.1 Sample Collection Custody Procedures

According to the U.S. EPA guidelines, a sample is considered to be in custody if one of the following conditions is met:

- It is in one's actual physical possession or view;
- It is in one's physical possession and has not been tampered with (i.e., it is under lock or official seal);
- It is retained in a secured area with restricted access; and
- It is placed in a container and secured with an official seal such that the sample cannot be reached without breaking the seal.

Place custody seals on sample containers immediately after sample collection and on shipping coolers if the cooler is to be removed from the sampler's custody. Place custody seals in such a manner that they must be broken to open the containers or coolers. Label the custody seals with the following information:

- Sampler's name or initials; and
- Date and time that the sample/cooler was sealed.

These seals are designed to enable detection of sample tampering. An example of a custody seal is shown in Attachment 1.

Field personnel shall also log individual samples onto COC forms (carbon copy or computer generated) when a sample is collected. These forms may also serve as the request for analyses. Procedures for completing these forms are discussed in Section 7.4, indicating sample identification number, matrix, date and time of collection, number of containers, analytical methods to be performed on the sample, and preservatives added (if any). The **samplers** will also sign the COC form signifying that they were the personnel who collected the samples. The COC form shall accompany the samples from the field to the laboratory. When a cooler is ready for shipment to the analytical laboratory, the **person delivering the samples for transport** will sign and indicate the date and time on the accompanying COC form. One copy of the COC form will be retained by the **sampler** and the remaining copies of the COC form shall be placed inside a self-sealing bag and taped to the inside of the cooler. Each cooler must be associated with a unique COC form. Whenever a transfer of custody takes place, **both parties** shall sign and date the accompanying carbon copy COC forms, and the **individual relinquishing the samples** shall retain a copy of each form. One exception is when the samples are shipped; the **delivery service personnel** will not sign or receive a copy because they do not open the coolers. The **laboratory** shall attach copies of the completed COC forms to the reports containing the results of the analytical tests. An example COC form is provided in Attachment 2.

5.3.2 Laboratory Custody Procedures

The following custody procedures are to be followed by an **independent laboratory** receiving samples for chemical analysis; the procedures in their Naval Facilities Engineering Service Center-evaluated Laboratory Quality Assurance Plan must follow these same procedures. A **designated sample custodian** shall take custody of all samples upon their arrival at the analytical laboratory. The **custodian** shall inspect all sample labels and COC forms to ensure that the information is consistent, and that each is properly completed. The **custodian** will also measure the temperature of the temperature blank in the coolers upon arrival using either a National Institute for Standards and Technology calibrated thermometer or an infra-red temperature gun. The **custodian** shall note the condition of the samples including:

- If the samples show signs of damage or tampering;
- If the containers are broken or leaking;
- If headspace is present in sample vials;
- If proper preservation of samples has occurred (made by pH measurement, except volatile organic compounds [VOCs] and purgeable total petroleum hydrocarbons [TPH] and temperature). The pH of VOC and purgeable TPH samples will be checked by the **laboratory analyst** after the sample aliquot has been removed from the vial for analysis; and
- If any sample holding times have been exceeded.

All of the above information shall be documented on a sample receipt sheet by the **custodian**.

Discrepancies or improper preservation shall be noted by the **laboratory** as an out-of-control event and shall be documented on an out-of-control form with corrective action taken. The out-of-control form shall be signed and dated by the **sample control custodian** and **any other persons** responsible for corrective action. An example of an out-of-control form is included as Attachment 4.

The **custodian** shall then assign a unique laboratory number to each sample and distribute the samples to secured storage areas maintained at 4 degrees Celsius (soil samples for VOC analysis are to be stored in a frozen state until analysis). The unique laboratory number for each sample, COC sample number, client name, date and time received, analysis due date, and storage shall also be manually logged onto a sample receipt record and later entered into the laboratory's computerized data management system. The **custodian** shall sign the shipping bill and maintain a copy.

Laboratory personnel shall be responsible for the care and custody of samples from the time of their receipt at the laboratory through their exhaustion or disposal. Samples should be logged in and out on internal laboratory COC forms each time they are removed from storage for extraction or analysis.

5.4 **Completing COC/Analytical Request Forms**

COC form/analytical request form completion procedures are crucial in properly transferring the custody and responsibility of samples from field personnel to the laboratory. This form is important for accurately and concisely requesting analyses for each sample; it is essentially a release order from the analysis subcontract.

Attachment 2 is an example of a generic COC/analytical request form that may be used by **field personnel**. Multiple copies may be tailored to each project so that much of the information described below need not be handwritten each time. Attachment 3 is an example of a completed site-specific COC/analytical request form, with box numbers identified and discussed in text below.

COC forms tailored to each CTO can be drafted and printed onto multi-ply forms. This eliminates the need to rewrite the analytical methods column headers each time. It also eliminates the need to write the project manager, name, and number; QC Level; TAT; and the same general comments each time.

Complete one COC form per cooler. Whenever possible, place all VOC analyte vials into one cooler in order to reduce the number of trip blanks. Complete all sections and be sure to sign and date the COC form. One copy of the COC form must remain with the field personnel.

Box 2 **Bill To:** List the name and address of the person/company to bill only if it is not in the subcontract with the laboratory.

Box 3 **Sample Disposal Instructions:** These instructions will be stated in the Master Service Agreement or each CTO statement of work with each laboratory.

Shipment Method: State the method of shipment (e.g., hand carry or air courier via FedEx or DHL).

Comments: This area shall be used by the field team to communicate observations, potential hazards, or limitations that may have occurred in the field or additional information regarding analysis (e.g., a specific metals list, samples expected to contain high analyte concentrations).

Box 4 **Cooler No.:** This will be written on the inside or outside of the cooler and shall be included on the COC. Some laboratories attach this number to the trip blank identification, which helps track samples for VOC analysis. If a number is not on the cooler, field personnel shall assign a number, write it on the cooler, and write it on the COC.

QC Level: Enter the reporting quality control (QC) requirements (e.g., Full Data Package, Summary Data Package).

Turnaround time (TAT): TAT will be determined by a sample delivery group (SDG), which may be formed over a 14-day period, not to exceed 20 samples. Once the SDG has been completed, standard TAT is 21 calendar days from receipt of the last sample in the SDG. Entering NORMAL or STANDARD in this field will be acceptable. If quicker TAT is required, it shall be in the subcontract with the laboratory and reiterated on each COC to remind the laboratory.

Box 5 **Type of Containers:** Write the type of container used (e.g., 1-liter glass amber, for a given parameter in that column).

Preservatives: Field personnel must indicate on the COC the correct preservative used for the analysis requested. Indicate the pH of the sample (if tested) in case there are buffering conditions found in the sample matrix.

Box 6 **Sample Identification (ID) Number:** This is typically a five-character alphanumeric identifier used by the contractor to identify samples. The use of this identifier is important since the laboratories are restricted to the number of characters they are able to use. Sample numbering shall be in accordance with the project-specific sampling and analysis plan.

Description (Sample ID): This name will be determined by the location and description of the sample, as described in the project-specific sampling and analysis plan. This sample identification should not be submitted to the laboratory, but should be left blank. If a computer COC version is used, the sample identification can be input, but printed with this block black. A cross-referenced list of the COC Sample Number and sample identification must be maintained separately.

Date Collected: Record the collection date in order to track the holding time of the sample. Note: For trip blanks, record the date it was placed in company with samples.

Time Collected: When collecting samples, record the time the sample is first collected. Use of the 24-hour military clock will avoid a.m. or p.m. designations (e.g., 1815 instead of 6:15 p.m.). Record local time; the laboratory is responsible for calculating holding times to local time.

Lab ID: This is for laboratory use only.

-
- Box 7 **Matrix/QC:** Identify the matrix (e.g., water, soil, air, tissue, fresh water sediment, marine sediment, or product). If a sample is expected to contain high analyte concentrations (e.g., a tank bottom sludge or distinct product layer), notify the laboratory in the comment section. Mark an "X" for the sample(s) that have extra volume for laboratory QC matrix spike/matrix spike duplicate (MS/MSD) purposes. The sample provided for MS/MSD purposes is usually a field duplicate.
- Box 8 **Analytical Parameters:** Enter the parameter by descriptor and the method number desired (e.g., BTEX 8260B, PAHs 8270C, etc.). Whenever practicable, list the parameters as they appear in the laboratory subcontract to maintain consistency and avoid confusion.
- If the COC does not have a specific box for number of sample containers, use the boxes below the analytical parameter, to indicate the number of containers collected for each parameter.
- Box 9 **Sampler's Signature:** The person who collected samples must sign here.
- Relinquished By:** The person who turned over the custody of the samples to a second party other than an express mail carrier, such as FedEx or DHL, must sign and date here.
- Received By:** Typically, a representative of the receiving laboratory signs and dates here. Or, a field crew member who delivered the samples in person from the field to the laboratory might sign here. A courier, such as FedEx or DHL, does not sign here because they do not open the coolers. It must also be used by the prime contracting laboratory when samples are to be sent to a subcontractor.
- Relinquished By:** In the case of subcontracting, the primary laboratory will sign and date the Relinquished By space and fill out an additional COC to accompany the samples being subcontracted.
- Received By (Laboratory):** This space is for the final destination (e.g., at a subcontracted laboratory). A representative of the final destination (e.g., subcontracted laboratory) must sign and date here.
- Box 10 **Lab No. and Questions:** This box is to be filled in by the laboratory only.
- Box 11 **Control Number:** This number is the "COC" followed by the first contractor identification number in that cooler, or contained on that COC. This control number must be unique (i.e., never used twice). Record the date the COC is completed. It should be the same date the samples are collected.
- Box 12 **Total # of Containers:** Sum the number of containers in that row.
- Box 13 **Totals:** Sum the number of containers in each column. Because COC forms contain different formats depending on who produced the form, not all of the information listed in items 1 to 13 may be recorded; however, as much of this information as possible shall be included.
-

6.0 Quality Control and Assurance

- 6.1 Recordkeeping, sample labeling, and chain-of-custody activities must incorporate quality control measures to ensure accuracy and completeness.
- 6.2 Deviations from this procedure or the project-specific CTO work plan shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

7.0 Records, Data Analysis, Calculations

- 7.1 The COC/analytical request form shall be faxed approximately daily to the **CTO Laboratory Coordinator** for verification of accuracy. Following the completion of sampling activities, the sample

logbook and COC forms will be transmitted to the **CTO Manager** for storage in project files. The **data validators** shall receive a copy also. The original COC/analytical request form shall be submitted by the **laboratory** along with the data delivered. Any changes to the analytical requests that are required shall be made in writing to the laboratory. A copy of this written change shall be sent to the data validators and placed in the project files. The reason for the change shall be included in the project files so that recurring problems can be easily identified.

- 7.2 Deviations from this procedure or the project-specific sampling and analysis plan shall be documented in the records. Significant changes shall be approved by the **Program Quality Manager**.

8.0 Attachments or References

- 8.1 Attachment 1 – Chain-of-Custody Seal
- 8.2 Attachment 2 – Generic Chain-of-Custody/Analytical Request Form
- 8.3 Attachment 3 – Sample Completed Chain-of-Custody
- 8.4 Attachment 4 – Sample Out-of-Control Form
- 8.5 Environmental Protection Agency, United States (EPA). 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*. Interim Final. EPA/540/G-89/004. Office of Emergency and Remedial Response. October.
- 8.6 EPA. 1992. *RCRA Groundwater Monitoring Draft Technical Guidance*. EPA/530/R-93/001. Office of Solid Waste. November.
- 8.7 EPA. 1997. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846. 3rd ed., Final Update IIIA. Office of Solid Waste.
- 8.8 Water Resources Control Board, State of California. 1988. *Technical Guidance Manual for Solid Waste Water Quality Assessment Test (SWAT) Proposals and Reports*. August.
- 8.9 Procedure 3-02, *Logbooks*.

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue

Attachment 1 Chain-of-Custody Seal

CHAIN-OF-CUSTODY SEAL

[LABORATORY]	SAMPLE NO.	DATE	SEAL BROKEN BY
	SIGNATURE		DATE
	PRINT NAME AND TITLE (<i>Inspector, Analyst or Technician</i>)		

Attachment 2

Generic Chain-of-Custody/Analytical Request Form

MG01376

CHAIN OF CUSTODY RECORD															Page ____ of ____	
Client/Project Name:					Project Location:					Analysis Requested						
Project Number:					Field Logbook No.:											
Sampler: (Print Name)/Affiliation:					Chain of Custody Tape No.:											
Signature:					Send Results/Report to:											
Field Sample No./ Identification	Date	Time	Grab	Comp	Sample Container (Size/Mat)	Sample Type (Liquid, Sludge, Etc.)	Preservative	Field Filtered							Lab I.D.	Remarks
Relinquished by: (Print Name)					Date:	Received by: (Print Name)					Date:	Analytical Laboratory (Destination):				
Signature:					Time:	Signature:					Time:					
Relinquished by: (Print Name)					Date:	Received by: (Print Name)					Date:					
Signature:					Time:	Signature:					Time:	Serial No.				
Relinquished by: (Print Name)					Date:	Received by: (Print Name)					Date:					
Signature:					Time:	Signature:					Time:					

Attachment 4

Sample Out-of-Control Form

OUT OF CONTROL FORM	Status	Date	Initial
	Noted OOC		
	Submit for CA*		
	Resubmit for CA*		
	Completed		

Date Recognized:	By:	Samples Affected (List by Accession AND Sample No.)
Dated Occurred:	Matrix	
Parameter (Test Code):	Method:	
Analyst:	Supervisor:	
1. Type of Event (Check all that apply)	2. Corrective Action (CA)* (Check all that apply)	
<input type="checkbox"/> Calibration Corr. Coefficient <0.995	<input type="checkbox"/> Repeat calibration	
<input type="checkbox"/> %RSD>20%	<input type="checkbox"/> Made new standards	
<input type="checkbox"/> Blank >MDL	<input type="checkbox"/> Reran analysis	
<input type="checkbox"/> Does not meet criteria:	<input type="checkbox"/> Sample(s) redigested and rerun	
<input type="checkbox"/> Spike	<input type="checkbox"/> Sample(s) reextracted and rerun	
<input type="checkbox"/> Duplicate	<input type="checkbox"/> Recalculated	
<input type="checkbox"/> LCS	<input type="checkbox"/> Cleaned system	
<input type="checkbox"/> Calibration Verification	<input type="checkbox"/> Ran standard additions	
<input type="checkbox"/> Standard Additions	<input type="checkbox"/> Notified	
<input type="checkbox"/> MS/MSD	<input type="checkbox"/> Other (please explain)	
<input type="checkbox"/> BS/BSD		
<input type="checkbox"/> Surrogate Recovery		
<input type="checkbox"/> Calculations Error		
<input type="checkbox"/> Holding Times Missed		
<input type="checkbox"/> Other (Please explain)	Comments:	

3. Results of Corrective Action	
<input type="checkbox"/>	Return to Control (indicated with)
<input type="checkbox"/>	Corrective Actions Not Successful - DATA IS TO BE FLAGGED with _____.

Analyst:	Date:
Supervisor:	Date:
QA Department:	Date:

Sample Handling, Storage, and Shipping

Procedure 3-04

1.0 Purpose and Scope

- 1.1 This standard operating procedure describes the actions to be used by personnel engaged in handling, storing, and transporting samples. The objective is to obtain samples of actual conditions with as little alteration as possible.
- 1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

- 2.1 Avoid lifting heavy coolers with back muscles; instead, use leg muscles or dollies.
- 2.2 Wear proper gloves, such as blue nitrile and latex, as defined in the project-specific health and safety plan, when handling sample containers to avoid contacting any materials that may have spilled out of the sample containers.

3.0 Terms and Definitions

None.

4.0 Training and Qualifications

- 4.1 The **Contract Task Order (CTO) Manager** and the **Laboratory Project Manager** are responsible for identifying instances of non-compliance with this procedure and ensuring that future sample transport activities comply with this procedure.
- 4.2 The **Field Manager** is responsible for ensuring that all samples are shipped according to this procedure.
- 4.3 **Field personnel** are responsible for the implementation of this procedure.
- 4.4 The **Program Quality Manager** is responsible for ensuring that sample handling, storage, and transport activities conducted during all CTOs comply with this procedure.
- 4.5 All **field personnel** are responsible for the implementation of this procedure.

5.0 Procedure

5.1 Handling and Storage

Immediately following collection, label all samples according to Procedure 3-03, *Recordkeeping, Sample Labeling, and Chain-of-Custody*. The lids of the containers shall not be sealed with duct tape, but may be covered with custody seals or placed directly into self-sealing bags. Place the sample containers in an insulated cooler with frozen gel packs (e.g., "blue ice") or ice in double, sealed self-sealing bags. Samples should occupy the lower portion of the cooler, while the ice should occupy the upper portion. Place an absorbent material (e.g., proper absorbent cloth material) on the bottom of the cooler to contain liquids in case of spillage. Fill all empty space between sample containers with Styrofoam® "peanuts" or other appropriate material. Prior to shipping, wrap glass sample containers on the sides, tops, and bottoms with bubble wrap or other appropriate padding and/or surround them in Styrofoam to

prevent breakage during transport. Pack all glass containers for water samples in an upright position, never stacked or on their sides. Prior to shipment, replace the ice or cold packs in the coolers so that samples will be maintained as close to 4 degrees Celsius (°C) as possible from the time of collection through transport to the analytical laboratory. Ship samples within 24 hours or on a schedule allowing the laboratory to meet holding times for analyses. The procedures for maintaining sample temperatures at 4°C pertain to all field samples.

5.2 **Shipping**

Follow all appropriate U.S. Department of Transportation regulations (e.g., 49 Code of Federal Regulations [CFR], Parts 171-179) for shipment of air, soil, water, and other samples. Elements of these procedures are summarized below.

5.2.1 **Hazardous Materials Shipment**

Field personnel must state whether any sample is suspected to be a hazardous material. A sample should be assumed hazardous unless enough evidence exists to indicate it is non-hazardous. If not suspected to be hazardous, shipments may be made as described in the Section 5.2.2 for non-hazardous materials. If hazardous, follow the procedures summarized below.

Any substance or material that is capable of posing an unreasonable risk to life, health, or property when transported is classified as hazardous. Perform hazardous materials identification by checking the list of dangerous goods for that particular mode of transportation. If not on that list, materials can be classified by checking the Hazardous Materials Table (49 CFR 172.102 including Appendix A) or by determining if the material meets the definition of any hazard class or division (49 CFR Part 173), as listed in Attachment 2.

All **persons shipping hazardous materials** must be properly trained in the appropriate regulations, as required by HM-126F, Training for Safe Transportation of Hazardous Materials (49 CFR HM-126F Subpart H). The training covers loading, unloading, handling, storing, and transporting of hazardous materials, as well as emergency preparedness in the case of accidents. **Carriers**, such as commercial couriers, must also be trained. Modes of shipment include air, highway, rail, and water.

When shipping hazardous materials, including bulk chemicals or samples suspected of being hazardous, the proper shipping papers (49 CFR 172 Subpart C), package marking (49 CFR 172 Subpart D), labeling (49 CFR 172 Subpart E), placarding (49 CFR 172 Subpart F, generally for carriers), and packaging must be used. Attachment 1 shows an example of proper package markings. Refer to a copy of 49 CFR each time hazardous materials/potentially hazardous samples are shipped.

According to Section 2.7 of the International Air Transport Association Dangerous Goods Regulations publication, very small quantities of certain dangerous goods may be transported without certain marking and documentation requirements as described in 49 CFR Part 172; however, other labeling and packing requirements must still be followed. Attachment 2 shows the volume or weight for different classes of substances. A "Dangerous Goods in Excepted Quantities" label must be completed and attached to the associated shipping cooler (Attachment 3). Certain dangerous goods are not allowed on certain airlines in any quantity.

As stated in item 4 of Attachment 4, the Hazardous Materials Regulations do not apply to hydrochloric acid (HCl), nitric acid (HNO₃), sulfuric acid (H₂SO₄), and sodium hydroxide (NaOH) added to water samples if their pH or percentage by weight criteria is met. These samples may be shipped as non-hazardous materials as discussed below.

5.2.2 **Non-Hazardous Materials Shipment**

If the samples are suspected to be non-hazardous based on previous site sample results, field screening results, or visual observations, if applicable, then samples may be shipped as non-hazardous.

When a cooler is ready for shipment to the laboratory, place two copies of the chain-of-custody form inside a self-sealing bag and tape it to the inside of the insulated cooler. Then, seal the cooler with waterproof tape and label it with "Fragile," "This-End-Up" (or directional arrows pointing up), or other appropriate notices. Place chain-of-custody seals on the coolers as discussed in Procedure 3-03, *Recordkeeping, Sample Labeling, and Chain-of-Custody*.

5.2.3 Shipments from Outside the Continental United States

Shipment of sample coolers to the United States from locations outside the continental United States is controlled by the U.S. Department of Agriculture (USDA) and is subject to their inspection and regulation. A "USDA Soil Import Permit" is required to prove that the receiving analytical laboratory is certified by the USDA to receive and properly dispose of soil. In addition, all sample coolers must be inspected by a **USDA representative**, affixed with a label indicating that the coolers contain environmental samples, and accompanied by shipping forms stamped by the **USDA inspector** prior to shipment.

In addition, the U.S. Customs Service must clear samples shipped from U.S. territorial possessions or foreign countries upon entry into the United States. As long as the commercial invoice is properly completed (see below), shipments typically pass through U.S. Customs Service without the need to open coolers for inspection.

Completion and use of proper paperwork will, in most cases, minimize or eliminate the need for the USDA and U.S. Customs Service to inspect the contents. Attachment 5 shows an example of how paperwork may be placed on the outside of coolers for non-hazardous materials. For hazardous materials, refer to Section 5.2.1.

In summary, tape the paperwork listed below to the outside of the coolers to accompany sample shipments. If a shipment is made up of multiple pieces (e.g., more than one cooler), the paperwork need only be attached to one cooler, provided that the **courier** agrees. All other coolers in the shipment need only to be taped and have the address and chain-of-custody seals affixed.

1. **Courier Shipping Form & Commercial Invoice:** See Attachment 6 and Attachment 7 for examples of the information to be included on the commercial invoices for soil and water, respectively. Place the courier shipping form and commercial invoice inside a clear, plastic, adhesive-backed pouch that adheres to the package (typically supplied by the courier) and place it on the cooler lid as shown in Attachment 5.
2. **Soil Import Permit (soil only):** See Attachment 8 and Attachment 9 for examples of the soil import permit and soil samples restricted entry labels, respectively. The **laboratory** shall supply these documents prior to mobilization. The USDA often stops shipments of soil without these documents. Staple together the 2-inch × 2-inch USDA label (described below) and soil import permit, and place them inside a clear plastic pouch. The **courier** typically supplies the clear, plastic, adhesive-backed pouches that adhere to the package.

Placing one restricted entry label as shown in Attachment 5 (covered with clear packing tape) and one stapled to the actual permit is suggested.

The USDA does not control water samples, so the requirements for soil listed above do not apply.

3. **Chain-of-Custody Seals:** The **laboratory** should supply the seals. **CTO personnel** must sign and date these. At least two seals should be placed in such a manner that they stick to both the cooler lid and body. Placing the seals over the tape (as shown in Attachment 5), then covering it with clear packing tape is suggested. This prevents the seal from coming loose and enables detection of tampering.
4. **Address Label:** Affix a label stating the destination (laboratory address) to each cooler.
5. **Special Requirements for Hazardous Materials:** See Section 5.2.1.

Upon receipt of sample coolers at the laboratory, the **sample custodian** shall inspect the sample containers as discussed in Procedure 3-03, *Recordkeeping, Sample Labeling, and Chain-of-Custody*. The samples shall then be immediately extracted and/or analyzed, or stored in a refrigerated storage area until they are removed for extraction and/or analysis. Whenever the samples are not being extracted or analyzed, they shall be returned to refrigerated storage.

6.0 Quality Control and Assurance

- 6.1 Sample handling, storage, and shipping must incorporate quality control measures to ensure conformance to these and the project requirements.

7.0 Records, Data Analysis, Calculations

- 7.1 Maintain records as required by implementing these procedures.
- 7.2 Deviations from this procedure or the project-specific sampling and analysis plan shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

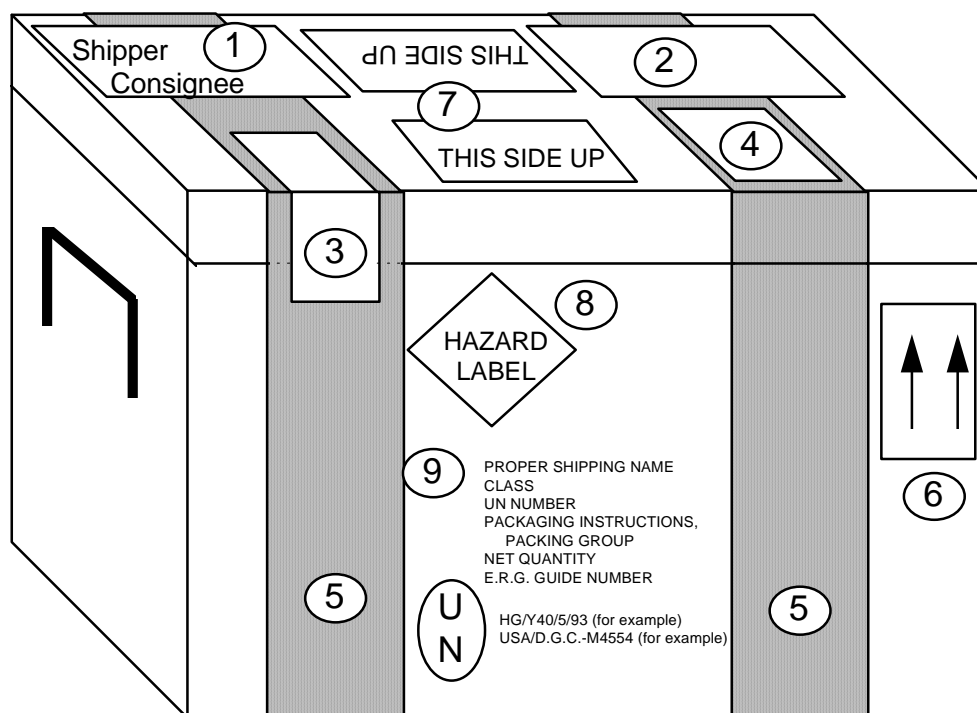
8.0 Attachments or Reference

- 8.1 Attachment 1 – Example Hazardous Material Package Marking
- 8.2 Attachment 2 – Packing Groups
- 8.3 Attachment 3 – Label for Dangerous Goods in Excepted Quantities
- 8.4 Attachment 4 – SW-846 Preservative Exception
- 8.5 Attachment 5 – Non-Hazardous Material Cooler Marking Figure for Shipment from Outside the Continental United States
- 8.6 Attachment 6 – Commercial Invoice – Soil
- 8.7 Attachment 7 – Commercial Invoice – Water
- 8.8 Attachment 8 – Soil Import Permit
- 8.9 Attachment 9 – Soil Samples Restricted Entry Labels
- 8.10 NAVSEA T0300-AZ-PRO-010. *Navy Environmental Compliance Sampling and Field Testing Procedures Manual*. August 2009.
- 8.11 Procedure 3-03, *Recordkeeping, Sample Labeling, and Chain-of-Custody*.

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue

Attachment 1

Example Hazardous Material Package Marking



- | | |
|--|---|
| ① AIR BILL/COMMERCIAL INVOICE | ⑥ DIRECTION ARROWS STICKER - TWO REQUIRED |
| ② USDA PERMIT (Letter to Laboratory from USDA) | ⑦ THIS SIDE UP STICKERS |
| ③ CUSTODY SEAL | ⑧ HAZARD LABEL |
| ④ USDA 2" X 2" SOIL IMPORT PERMIT | ⑨ HAZARDOUS MATERIAL INFORMATION |
| ⑤ WATERPROOF STRAPPING TAPE | ⑩ PACKAGE SPECIFICATIONS |

Attachment 2

Packing Groups

PACKING GROUP OF THE SUBSTANCE	PACKING GROUP I		PACKING GROUP II		PACKING GROUP III	
CLASS or DIVISION of PRIMARY or SUBSIDIARY RISK	Packagings		Packagings		Packagings	
	Inner	Outer	Inner	Outer	Inner	Outer
1: Explosives	Forbidden ^(Note A)					
2.1: Flammable Gas	Forbidden ^(Note B)					
2.2: Non-Flammable, non-toxic gas	See Notes A and B					
2.3: Toxic gas	Forbidden ^(Note A)					
3: Flammable liquid	30 mL	300 mL	30 mL	500 mL	30 mL	1 L
4.1 Self-reactive substances	Forbidden		Forbidden		Forbidden	
4.1: Other flammable solids	Forbidden		30 g	500 g	30 g	1 kg
4.2: Pyrophoric substances	Forbidden		Not Applicable		Not Applicable	
4.2 Spontaneously combustible substances	Not Applicable		30 g	500 g	30 g	1 kg
4.3: Water reactive substances	Forbidden		30 g or 30 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
5.1: Oxidizers	Forbidden		30 g or 30 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
5.2: Organic peroxides ^(Note C)	See Note A		30 g or 30 mL	500 g or 250 mL	Not Applicable	
6.1: Poisons - Inhalation toxicity	Forbidden		1 g or 1 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
6.1: Poisons - oral toxicity	1 g or 1 mL	300 g or 300 mL	1 g or 1 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
6.1: Poisons - dermal toxicity	1 g or 1 mL	300 g or 300 mL	1 g or 1 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
6.2: Infectious substances	Forbidden ^(Note A)					
7: Radioactive material ^(Note D)	Forbidden ^(Note A)					
8: Corrosive materials	Forbidden		30 g or 30 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
9: Magnetized materials	Forbidden ^(Note A)					
9: Other miscellaneous materials ^(Note E)	Forbidden		30 g or 30 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L

Note A: Packing groups are not used for this class or division.

Note B: For inner packagings, the quantity contained in receptacle with a water capacity of 30 mL. For outer packagings, the sum of the water capacities of all the inner packagings contained must not exceed 1 L.

Note C: Applies only to Organic Peroxides when contained in a chemical kit, first aid kit or polyester resin kit.

Note D: See 6.1.4.1, 6.1.4.2, and 6.2.1.1 through 6.2.1.7, radioactive material in excepted packages.

Note E: For substances in Class 9 for which no packing group is indicated in the List of Dangerous Goods, Packing Group II quantities must be used.

Attachment 3

Dangerous Goods in Excepted Quantities

DANGEROUS GOODS IN EXCEPTED QUANTITIES							
<p>This package contains dangerous goods in excepted small quantities and is in all respects in compliance with the applicable international and national government regulations and the IATA Dangerous Goods Regulations.</p>							
<hr style="border: 0; border-top: 1px solid black; margin-bottom: 5px;"/> Signature of Shipper							
<hr style="border: 0; border-top: 1px solid black; margin-bottom: 5px;"/> Title				<hr style="border: 0; border-top: 1px solid black; margin-bottom: 5px;"/> Date			
<hr style="border: 0; border-top: 1px solid black; margin-bottom: 5px;"/> Name and address of Shipper							
<p>This package contains substance(s) in Class(es) (check applicable box(es))</p>							
Class:	2	3	4	5	6	8	9
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
and the applicable UN Numbers are:							

Attachment 4

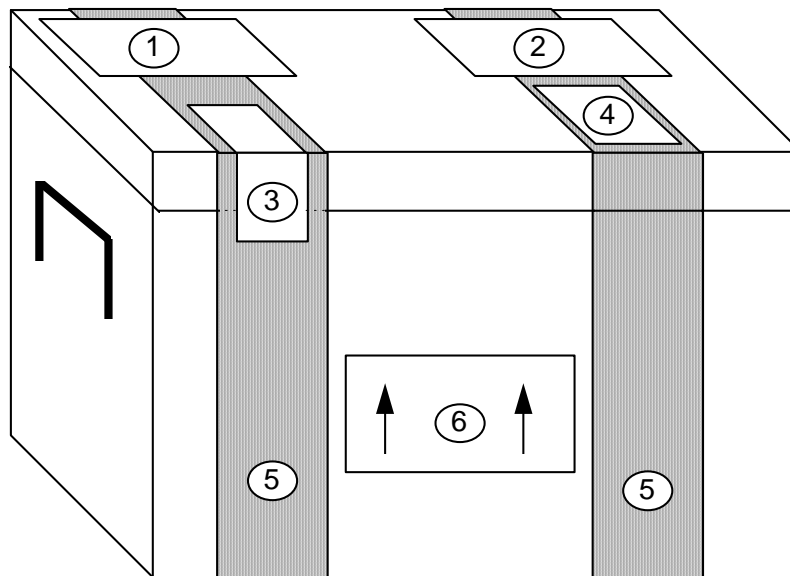
SW-846 Preservative Exception

Measurement	Vol. Req. (mL)	Container ²	Preservative ^{3,4}	Holding Time ⁵
MBAS	250	P, G	Cool, 4°C	48 Hours
NTA	50	P, G	Cool, 4°C	24 Hours

1. More specific instructions for preservation and sampling are found with each procedure as detailed in this manual. A general discussion on sampling water and industrial wastewater may be found in ASTM, Part 31, p. 72-82 (1976) Method D-3370.
2. Plastic (P) or Glass (G). For metals, polyethylene with a polypropylene cap (no liner) is preferred.
3. Sample preservation should be performed immediately upon sample collection. For composite samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
4. When any sample is to be shipped by common carrier or sent through the United States Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of Table 1, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentration of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO₃) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H₂SO₄) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).
5. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of sample under study are stable for the longer time, and has received a variance from the Regional Administrator. Some samples may not be stable for the maximum time period given in the table. A permittee, or monitoring laboratory, is obligated to hold the sample for a shorter time if knowledge exists to show this is necessary to maintain sample stability.
6. Should only be used in the presence of residual chlorine.

Attachment 5

Non-Hazardous Material Cooler Marking Figure for Shipment from Outside the Continental United States



- ① AIR BILL/COMMERCIAL INVOICE
- ② USDA PERMIT (Letter to Laboratory from USDA)
- ③ CUSTODY SEAL
- ④ USDA 2" X 2" SOIL IMPORT PERMIT
- ⑤ WATERPROOF STRAPPING TAPE
- ⑥ DIRECTION ARROWS STICKER - TWO REQUIRED

Attachment 6

Commercial Invoice – Soil

DATE OF EXPORTATION 1/1/94				EXPORT REFERENCES (i.e., order no., invoice no., etc.) <CJO #>				
SHIPPER/EXPORTER (complete name and address) Joe Smith Ogden c/o <hotel name> <hotel address>				CONSIGNEE Sample Receipt <Lab Name> <Lab Address>				
COUNTRY OF EXPORT Guam, USA				IMPORTER - IF OTHER THAN CONSIGNEE				
COUNTRY OF ORIGIN OF GOODS Guam, USA								
COUNTRY OF ULTIMATE DESTINATION USA								
INTERNATIONAL AIR WAYBILL NO.				<div style="border: 1px solid black; width: 200px; height: 30px; margin: 0 auto;"></div> (NOTE: All shipments must be accompanied by a Federal Express International Air Waybill)				
MARKS/NOS	NO. OF PKGS	TYPE OF PACKAGING	FULL DESCRIPTION OF GOODS	QTY	UNIT OF MEASURE	WEIGHT	UNIT VALUE	TOTAL VALUE
	3	coolers	Soil samples for laboratory analysis only				\$1.00	\$3.00
		TOTAL NO. OF PKGS.				TOTAL WEIGHT		TOTAL INVOICE VALUE
		3						\$3.00
Check one <input type="checkbox"/> F.O.B. <input type="checkbox"/> C&F <input type="checkbox"/> C.I.F.								

THESE COMMODITIES ARE LICENSED FOR THE ULTIMATE DESTINATION SHOWN.

DIVERSION CONTRARY TO UNITED STATES LAW IS PROHIBITED.

I DECLARE ALL THE INFORMATION CONTAINED IN THIS INVOICE TO BE TRUE AND CORRECT

SIGNATURE OF SHIPPER/EXPORTER (Type name and title and sign)

Joe Smith, Ogden

Joe Smith

1/1/94

Name/Title

Signature

Date

Attachment 7

Commercial Invoice – Water

DATE OF EXPORTATION <i>1/1/94</i>				EXPORT REFERENCES (i.e., order no., invoice no., etc.) <CJO #>				
SHIPPER/EXPORTER (complete name and address) <i>Joe Smith</i> <i>Ogden</i> c/o <hotel name> <hotel address>				CONSIGNEE <i>Sample Receipt</i> <Lab Name> <Lab Address>				
COUNTRY OF EXPORT <i>Guam, USA</i>				IMPORTER - IF OTHER THAN CONSIGNEE				
COUNTRY OF ORIGIN OF GOODS <i>Guam, USA</i>								
COUNTRY OF ULTIMATE DESTINATION <i>USA</i>								
INTERNATIONAL AIR WAYBILL NO.				<div style="border: 1px solid black; width: 150px; height: 30px; margin: 0 auto;"></div>		(NOTE: All shipments must be accompanied by a Federal Express International Air Waybill)		
MARKS/NOS	NO. OF PKGS	TYPE OF PACKAGING	FULL DESCRIPTION OF GOODS	QTY	UNIT OF MEASURE	WEIGHT	UNIT VALUE	TOTAL VALUE
	<i>3</i>	<i>coolers</i>	<i>Water samples for laboratory analysis only</i>				<i>\$1.00</i>	<i>\$3.00</i>
						TOTAL WEIGHT	TOTAL INVOICE VALUE	
							<i>\$3.00</i>	
Check one <input type="checkbox"/> F.O.B. <input type="checkbox"/> C&F <input type="checkbox"/> C.I.F.								

THESE COMMODITIES ARE LICENSED FOR THE ULTIMATE DESTINATION SHOWN.

DIVERSION CONTRARY TO UNITED STATES LAW IS PROHIBITED.

I DECLARE ALL THE INFORMATION CONTAINED IN THIS INVOICE TO BE TRUE AND CORRECT


SIGNATURE OF SHIPPER/EXPORTER (Type name and title and sign)

Joe Smith, Ogden

Joe Smith

1/1/94

Attachment 8 Soil Import Permit

 <p>UNITED STATES DEPARTMENT OF AGRICULTURE</p> <p>Animal and Plant Health Inspection Service</p> <p>Plant Protection and Quarantine</p>	<h3 style="margin: 0;">Soil Permit</h3> <p>Issued To:</p> <p>Columbia Analytical Services (Lee Wolf) 1317 S. 13th Avenue Kelso, Washington 98626</p> <p>TELEPHONE: (360) 577-7222</p>	<p>Permit Number: S-52239</p>	<p>Under the authority of the Federal Plant Pest Act of May 23, 1957, permission is hereby granted to the facility/individual named above subject to the following conditions:</p> <ol style="list-style-type: none"> 1. Valid for shipments of soil not heat treated at the port of entry, only if a compliance agreement (PPQ Form 519) has been completed and signed. Compliance Agreements and Soil permits are non-transferable. If you hold a Soil Permit and you leave your present employer or company, you must notify your local USDA office promptly. 2. To be shipped in sturdy, leakproof, containers. 3. To be released without treatment at the port of entry. 4. To be used only for analysis and only in the facility of the permittee at Columbia Analytical Services, located in Kelso, Washington. 5. No use of soil for growing purposes is authorized, including the isolation or culture of organisms imported in soil. 6. All unconsumed soil, containers, and effluent is to be autoclaved, incinerated, or heat treated by the permittee at the conclusion of the project as approved and prescribed by Plant Protection and Quarantine. 7. This permit authorizes shipments from all foreign sources, including Guam, Hawaii, Puerto Rico, and the U.S. Virgin Islands through any U.S. port of entry.
		<p>JUNE 30, 2006</p> <p>Expiration Date</p>	<p><i>Deborah M. Knott</i></p> <p>Approving Official DEBORAH M. KNOTT</p>
<p>WARNING: Any alteration, forgery, or unauthorized use of this Federal form is subject to civil penalties of up to \$250,000 (7 U.S.C. s 7754(b)) or punishable by a fine of not more than \$10,000, or imprisonment of not more than 5 years, or both (18 U.S.C. s 1001).</p>			<p>PPQ FORM 525B (8/94)</p>

Pt. 1 - PERMITTEE

Attachment 9

Soil Samples Restricted Entry Labels

<p>U.S. DEPARTMENT OF AGRICULTURE</p> <p>ANIMAL AND PLANT HEALTH INSPECTION</p> <p>SERVICE</p> <p>PLANT PROTECTION AND QUARANTINE</p> <p>HYATTSVILLE, MARYLAND 20782</p> <p>SOIL SAMPLES</p> <p>RESTRICTED ENTRY</p> <p>The material contained in this package is imported under authority of the Federal Plant Pest Act of May 23, 1957.</p> <p>For release without treatment if addressee is currently listed as approved by Plant Protection and Quarantine.</p> <p>PPQ FORM 550 <i>Edition of 12/77 may be used</i></p> <p>(JAN 83)</p>

Investigation Derived Waste Management

Procedure 3-05

1.0 Purpose and Scope

This standard operating procedure (SOP) describes activities and responsibilities of the United States (U.S.) Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command, Atlantic (NAVFAC Atlantic) with regard to management of investigation-derived waste (IDW). The purpose of this procedure is to provide guidance for the minimization, handling, labelling, temporary storage, inventory, classification, and disposal of IDW generated under the ER Program. This procedure will also apply to personal protective equipment (PPE), sampling equipment, decontamination fluids, non-IDW trash, non-indigenous IDW, and hazardous waste generated during implementation of removal or remedial actions. The information presented will be used to prepare and implement work plans (WPs) for IDW-related field activities. The results from implementation of WPs will then be used to develop and implement final IDW disposal plans.

If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to IDW then those procedures may be added as an appendix to the project specific SAP.

This procedure applies to all Navy ER projects performed in the NAVFAC Atlantic Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved by both the Contract Task Order (CTO) Manager and the Quality Assurance (QA) Manager or Technical Director, and documented.

This procedure was developed to serve as management-approved professional guidance for the management of IDW generated under the ER Program. It focuses on the requirements for minimizing, segregating, handling, labeling, storing, and inventorying IDW in the field. Certain drum inventory requirements related to the screening, sampling, classification, and disposal of IDW are also noted in this procedure.

2.0 Safety

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the CTO WP and/or direction from the **Site Safety Officer (SSO)**.

All **Field Personnel** responsible for IDW management must adhere to the HASP and must wear the PPE specified in the site-specific HASP. Generally, this includes, at a minimum, steel-toed boots or steel-toed rubber boots, safety glasses, American National Standards Institute-standard hard hats, and hearing protection (if heavy equipment is in operation). If safe alternatives are not achievable, discontinue site activities immediately.

3.0 Terms and Definitions

None.

4.0 Training and Qualifications

- 4.1 The **CTO Manager** is responsible for ensuring that IDW management activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all personnel involved in IDW management shall have the appropriate education, experience, and training to perform their assigned tasks.
- 4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 4.3 The **Field Manager** is responsible for ensuring that all IDW is managed according to this procedure.
- 4.4 All **Field Personnel** are responsible for the implementation of this procedure.

5.0 Equipment and Supplies

The equipment and supplies required for implementation of this SOP include the following:

- Containers for waste (e.g., [U.S. Department of Transportation] DOT approved 55-gallon open and closed top drums) and material to cover waste to protect from weather (e.g., plastic covering);
- Hazardous /non-hazardous waste drum labels (weatherproof);
- Permanent marking pens;
- Inventory forms for project file;
- Plastic garbage bags, zip lock storage bags, roll of plastic sheeting; and
- Steel-toed boots, chemical resistant gloves, coveralls, safety glasses, and any other PPE required in the HASP.

6.0 Procedure

The following procedures are used to handle the IDW.

6.1 Drum Handling

- 6.1.1 IDW shall be containerized using DOT approved drums. The drums shall be made of steel or plastic, have a 55-gallon capacity, be completely painted or opaque, and have removable lids (i.e., United Nations Code 1A2 or 1H2). Typically 55-gallon drums are used, however small drums may be used depending on the amount of waste generated. New steel drums are preferred over recycled drums.
- 6.1.2 Recycled drums should not be used for hazardous waste, PCBs or other regulated shipments. For short-term storage of liquid IDW prior to discharge, double-walled bulk steel or plastic storage tanks may be used. For this scenario, consider the scheduling and cost-effectiveness of this type of bulk storage, treatment, and discharge system versus longer-term drum storage.
- 6.1.3 For long-term IDW storage at other project locations, the DOT approved drums with removable lids are recommended. Verify the integrity of the foam or rubber sealing ring located on the underside of some drum lids prior to sealing drums containing IDW liquids.
- 6.1.4 If the ring is only partially attached to the drum lid, or if a portion of the ring is missing, select another drum lid with a sealing ring that is in sound condition.
- 6.1.5 To prepare IDW drums for labeling, wipe clean the outer wall surfaces and drum lids of all material that might prevent legible and permanent labeling. If potentially contaminated material adheres to the outer surface of a drum, wipe that material from the drum, and segregate the paper towel or rag used to remove the material with visibly soiled PPE and

disposable sampling equipment. Label all IDW drums and place them on pallets prior to storage.

6.2 Labelling

- 6.2.1 Containers used to store IDW must be properly labelled. Two general conditions exist: 1) from previous studies or on-site data, waste characteristics are known to be either hazardous or nonhazardous; or 2) waste characteristics are unknown until additional data are obtained.
- 6.2.2 For situations where the waste characteristics are known, the waste containers should be packaged and labelled in accordance with state regulations and any federal regulations that may govern the labelling of waste.
- 6.2.3 The following information shall be placed on all non-hazardous waste labels:
- Description of waste (i.e., purge water, soil cuttings);
 - Contact information (i.e., contact name and telephone number);
 - Date when the waste was first accumulated.
- 6.2.4 The following information shall be placed on all hazardous waste labels:
- Description of waste (i.e., purge water, soil cuttings);
 - Generator information (i.e., name, address, contact telephone number);
 - EPA identification number (supplied by on-site client representative);
 - Date when the waste was first accumulated.
- 6.2.5 When the final characterization of a waste is unknown, a notification label should be placed on the drum with the words "waste characterization pending analysis" and the following information included on the label:
- Description of waste (i.e., purge water, soil cuttings);
 - Contact information (i.e., contact name and telephone number);
 - Date when the waste was first accumulated.
- 6.2.6 Once the waste has been characterized, the label should be changed as appropriate for a nonhazardous or hazardous waste.
- 6.2.7 Waste labels should be constructed of a weatherproof material and filled out with a permanent marker to prevent being washed off or becoming faded by sunlight. It is recommended that waste labels be placed on the side of the container, since the top is more subject to weathering. However, when multiple containers are accumulated together, it also may be helpful to include labels on the top of the containers to facilitate organization and disposal.
- 6.2.8 Each container of waste generated shall be recorded in the field notebook used by the person responsible for labelling the waste. After the waste is disposed of, either by transportation off-site or disposal on-site in an approved disposal area, an appropriate record shall be made in the same field notebook to document proper disposition of IDW.

6.3 **Types of Site Investigation Waste**

Several types of waste are generated during site investigations that may require special handling. These include solid, liquid, and used PPE, as discussed further below.

Solid Waste

Soil cuttings from boreholes will typically be placed in containers unless site specific requirements allow for soil cuttings to be placed back into the borehole after drilling is complete. Drilling mud generated during investigation activities shall be collected in containers. Covers should be included on the containers and must be secured at all times and only open during filling activities. The containers shall be labelled in accordance with this SOP. An inventory containing the source, volume, and description of material put in the containers shall be logged on prescribed forms and kept in the project file.

Non-hazardous solid waste can be disposed on-site in the designated site landfill or in a designated evaporation pond if it is liquefied. Hazardous wastes must be disposed off-site at an approved hazardous waste landfill.

Liquid Waste

Groundwater generated during monitoring well development, purging, and sampling can be collected in truck-mounted containers and/or other transportable containers (i.e., 55-gallon drums). Lids or bungs on drums must be secured at all times and only open during filling or pumping activities. The containers shall be labelled in accordance with this SOP. Non-hazardous liquid waste can be disposed of in one of the designated lined evaporation ponds on-site. Hazardous wastes must be handled separately and disposed off-site at an approved hazardous waste facility.

Personal Protective Equipment

PPE that is generated throughout investigation activities shall be placed in plastic garbage bags. If the solid or liquid waste that was being handled is characterized as hazardous waste, then the corresponding PPE should also be disposed as hazardous waste. If not, all PPE should be disposed as non-hazardous waste in the designated on-site landfill. Trash that is generated as part of field activities may be disposed of in the landfill as long as the trash was not exposed to hazardous media.

6.4 **Waste Accumulation On-Site**

- 6.4.1 Solid, liquid, or PPE waste generated during investigation activities that are classified as nonhazardous or "characterization pending analysis" should be disposed of as soon as possible. Until disposal, such containers should be inventoried, stored as securely as possible, and inspected regularly, as a general good practice.
- 6.4.2 Solid, liquid, or PPE waste generated during investigation activities that are classified as hazardous shall not be accumulated on-site longer than 90 days. All hazardous waste containers shall be stored in a secured storage area. The following requirements for the hazardous waste storage area must be implemented:
 - Proper hazardous waste signs shall be posted as required by any state or federal statutes that may govern the labelling of waste;
 - Secondary containment to contain spills;
 - Spill containment equipment must be available;
 - Fire extinguisher;
 - Adequate aisle space for unobstructed movement of personnel.

- 6.4.3 Weekly storage area inspections shall be performed and documented to ensure compliance with these requirements. Throughout the project, an inventory shall be maintained to itemize the type and quantity of the waste generated.

6.5 Waste Disposal

- 6.5.1 Solid, liquid, and PPE waste will be characterized for disposal through the use of client knowledge, laboratory analytical data created from soil or groundwater samples gathered during the field activities, and/or composite samples from individual containers.
- 6.5.2 All waste generated during field activities will be stored, transported, and disposed of according to applicable state, federal, and local regulations. All wastes classified as hazardous will be disposed of at a licensed treatment storage and disposal facility or managed in other approved manners.
- 6.5.3 In general, waste disposal should be carefully coordinated with the facility receiving the waste. Facilities receiving waste have specific requirements that vary even for non-hazardous waste, so characterization should be conducted to support both applicable regulations and facility requirements.

6.6 Regulatory Requirements

The following federal and state regulations shall be used as resources for determining waste characteristics and requirements for waste storage, transportation, and disposal:

- Code of Federal Regulations (CFR), Title 40, Part 261;
- CFR, Title 49, Parts 172, 173, 178, and 179.

6.7 Waste Transport

A state-certified hazardous waste hauler shall transport all wastes classified as hazardous. Typically, the facility receiving any waste can coordinate a hauler to transport the waste. Shipped hazardous waste shall be disposed of in accordance with all RCRA/USEPA requirements. All waste manifests or bills of lading will be signed either by the client or the client's designee.

7.0 Quality Control and Assurance

- 7.1 Management of IDW must incorporate quality control measures to ensure conformance to these and the project requirements.

8.0 Records, Data Analysis, Calculations

- 8.1 Maintain records as required by implanting the procedures in this SOP.
- 8.2 Deviations from this procedure or the sampling and analysis plan shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

9.0 Attachments or References

Department of Defense, United States (DoD). 2005. [*Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*](#). Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/-fedfac/pdf/ufp_qapp_v1_0305.pdf.

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NAVFAC NW Standard Operating Procedure Number I-F, *Equipment Decontamination*.

NAVFAC NW Standard Operating Procedure Number III-D, *Logbooks*.

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

Equipment Decontamination

Procedure 3-06

1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes methods of equipment decontamination, to be used for activities where samples for chemical analysis are collected or where equipment will need to be cleaned before leaving the site or before use in subsequent activities.
- 1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

It is the responsibility of the **Site Safety Officer (SSO)** to set up the site zones (i.e., exclusion, transition, and clean) and decontamination areas. Generally the decontamination area is located within the transition zone, upwind of intrusive activities, and serves as the washing area for both personnel and equipment to minimize the spread of contamination into the clean zone. Typically, for equipment, a series of buckets are set up on a visqueen-lined bermed area. Separate spray bottles containing cleaning solvents as described in this procedure or the Contract Task Order (CTO) Work Plan (WP) and distilled water are used for final rinsing of equipment. Depending on the nature of the hazards and the site location, decontamination of heavy equipment, such as augers, pump drop pipe, and vehicles, may be accomplished using a variety of techniques.

All **Field Personnel** responsible for equipment decontamination must adhere to the site-specific health and safety plan (HSP) and must wear the personal protective equipment (PPE) specified in the site-specific HSP. Generally this includes, at a minimum, Tyvek® coveralls, steel-toed boots with boot covers or steel-toed rubber boots, safety glasses, American National Standards Institute-standard hard hats, and hearing protection (if heavy equipment is in operation). Air monitoring by the **SSO** may result in an upgrade to the use of respirators and cartridges in the decontamination area; therefore, this equipment must be available on site. If safe alternatives are not achievable, discontinue site activities immediately.

In addition to the aforementioned precautions, the following sections describe safe work practices that will be employed.

2.1 Chemical Hazards associated with Equipment Decontamination

- Avoid skin contact with and/or incidental ingestion of decontamination solutions and water.
- Utilize PPE as specified in the site-specific HSP to maximize splash protection.
- Refer to material safety data sheets, safety personnel, and/or consult sampling personnel regarding appropriate safety measures (i.e., handling, PPE including skin and respiratory).
- Take the necessary precautions when handling detergents and reagents.

2.2 Physical Hazards associated with Equipment Decontamination

- To avoid possible back strain, it is recommended to raise the decontamination area 1 to 2 feet above ground level.
- To avoid heat stress, over exertion, and exhaustion, it is recommended to rotate equipment decontamination among all site personnel.

- Take necessary precautions when handling field sampling equipment.

3.0 Terms and Definitions

None.

4.0 Training and Qualifications

- 4.1 The **CTO Manager** is responsible for ensuring that decontamination activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all personnel involved in equipment decontamination shall have the appropriate education, experience, and training to perform their assigned tasks.
- 4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 4.3 The **Field Manager** is responsible for ensuring that all field equipment is decontaminated according to this procedure.
- 4.4 All **Field Personnel** are responsible for the implementation of this procedure.

5.0 Procedure

Decontamination of equipment used in soil/sediment sampling, groundwater monitoring, well drilling and well development, as well as equipment used to sample groundwater, surface water, sediment, waste, wipe, asbestos, and unsaturated zone, is necessary to prevent cross-contamination and to maintain the highest integrity possible in collected samples. Planning a decontamination program requires consideration of the following factors:

- Location where the decontamination procedures will be conducted
- Types of equipment requiring decontamination
- Frequency of equipment decontamination
- Cleaning technique and types of cleaning solutions appropriate to the contaminants of concern
- Method for containing the residual contaminants and wash water from the decontamination process
- Use of a quality control measure to determine the effectiveness of the decontamination procedure

The following subsections describe standards for decontamination, including the frequency of decontamination, cleaning solutions and techniques, containment of residual contaminants and cleaning solutions, and effectiveness.

5.1 Decontamination Area

Select an appropriate location for the decontamination area at a site based on the ability to control access to the area, the ability to control residual material removed from equipment, the need to store clean equipment, and the ability to restrict access to the area being investigated. Locate the decontamination area an adequate distance away and upwind from potential contaminant sources to avoid contamination of clean equipment.

5.2 Types of Equipment

Drilling equipment that must be decontaminated includes drill bits, auger sections, drill-string tools, drill rods, split barrel samplers, tremie pipes, clamps, hand tools, and steel cable. Decontamination of monitoring well development and groundwater sampling equipment includes submersible pumps, bailers, interface probes, water level meters, bladder pumps, airlift pumps, peristaltic pumps, and lysimeters. Other sampling equipment that requires decontamination includes, but is not limited to, hand trowels,

hand augers, slide hammer samplers, shovels, stainless-steel spoons and bowls, soil sample liners and caps, wipe sampling templates, composite liquid waste samplers, and dippers. Equipment with a porous surface, such as rope, cloth hoses, and wooden blocks, cannot be thoroughly decontaminated and shall be properly disposed of after one use.

5.3 **Frequency of Equipment Decontamination**

Decontaminate down-hole drilling equipment and equipment used in monitoring well development and purging prior to initial use and between each borehole or well. Down-hole drilling equipment, however, may require more frequent cleaning to prevent cross-contamination between vertical zones within a single borehole. When drilling through a shallow contaminated zone and installing a surface casing to seal off the contaminated zone, decontaminate the drilling tools prior to drilling deeper. Initiate groundwater sampling by sampling groundwater from the monitoring well where the least contamination is suspected. Decontaminate groundwater, surface water, and soil sampling devices prior to initial use and between collection of each sample to prevent the possible introduction of contaminants into successive samples.

5.4 **Cleaning Solutions and Techniques**

Decontamination can be accomplished using a variety of techniques and fluids. The preferred method of decontaminating major equipment, such as drill bits, augers, drill string, and pump drop-pipe, is steam cleaning. To steam clean, use a portable, high-pressure steam cleaner equipped with a pressure hose and fittings. For this method, thoroughly steam wash equipment and rinse it with potable tap water to remove particulates and contaminants.

A rinse decontamination procedure is acceptable for equipment such as bailers, water level meters, new and re-used soil sample liners, and hand tools. The decontamination procedure shall consist of the following: (1) wash with a non-phosphate detergent (Alconox®, Liquinox®, or other suitable detergent) and potable water solution; (2) rinse with potable water; (3) spray with laboratory-grade isopropyl alcohol; (4) rinse with deionized or distilled water; and (5) spray with deionized or distilled water. If possible, disassemble equipment prior to cleaning. Add a second wash at the beginning of the process if equipment is very soiled.

Decontaminating submersible pumps requires additional effort because internal surfaces become contaminated during usage. Decontaminate these pumps by washing and rinsing the outside surfaces using the procedure described for small equipment or by steam cleaning. Decontaminate the internal surfaces by recirculating fluids through the pump while it is operating. This recirculation may be done using a relatively long (typically 4 feet) large-diameter pipe (4-inch or greater) equipped with a bottom cap. Fill the pipe with the decontamination fluids, place the pump within the capped pipe, and operate the pump while recirculating the fluids back into the pipe. The decontamination sequence shall include: (1) detergent and potable water; (2) potable water rinse; (3) potable water rinse; and (4) deionized water rinse. Change the decontamination fluids after each decontamination cycle.

Solvents other than isopropyl alcohol may be used, depending upon the contaminants involved. For example, if polychlorinated biphenyls or chlorinated pesticides are contaminants of concern, hexane may be used as the decontamination solvent; however, if samples are also to be analyzed for volatile organics, hexane shall not be used. In addition, some decontamination solvents have health effects that must be considered. Decontamination water shall consist of distilled or deionized water. Steam-distilled water shall not be used in the decontamination process as this type of water usually contains elevated concentrations of metals. Decontamination solvents to be used during field activities will be specified in the CTO WP.

Rinse equipment used for measuring field parameters, such as pH (indicates the hydrogen ion concentration – acidity or basicity), temperature, specific conductivity, and turbidity with deionized or distilled water after each measurement. Also wash new, unused soil sample liners and caps with a fresh

detergent solution and rinse them with potable water followed by distilled or deionized water to remove any dirt or cutting oils that might be on them prior to use.

5.5 **Containment of Residual Contaminants and Cleaning Solutions**

A decontamination program for equipment exposed to potentially hazardous materials requires a provision for catchment and disposal of the contaminated material, cleaning solution, and wash water.

When contaminated material and cleaning fluids must be contained from heavy equipment, such as drill rigs and support vehicles, the area must be properly floored, preferably with a concrete pad that slopes toward a sump pit. If a concrete pad is impractical, planking can be used to construct solid flooring that is then covered by a nonporous surface and sloped toward a collection sump. If the decontamination area lacks a collection sump, use plastic sheeting and blocks or other objects to create a bermed area for collection of equipment decontamination water. Situate items, such as auger flights, which can be placed on metal stands or other similar equipment, on this equipment during decontamination to prevent contact with fluids generated by previous equipment decontamination. Store clean equipment in a separate location to prevent recontamination. Collect decontamination fluids contained within the bermed area and store them in secured containers as described below.

Use wash buckets or tubs to catch fluids from the decontamination of lighter-weight drilling equipment and hand-held sampling devices. Collect the decontamination fluids and store them on site in secured containers, such as U.S. Department of Transportation-approved drums, until their disposition is determined by laboratory analytical results. Label containers in accordance with Procedure 3-05, *IDW Management*.

6.0 **Quality Control and Assurance**

A decontamination program must incorporate quality control measures to determine the effectiveness of cleaning methods. Quality control measures typically include collection of equipment blank samples or wipe testing. Equipment blanks consist of analyte-free water that has been poured over or through the sample collection equipment after its final decontamination rinse. Wipe testing is performed by wiping a cloth over the surface of the equipment after cleaning. These quality control measures provide "after-the-fact" information that may be useful in determining whether or not cleaning methods were effective in removing the contaminants of concern.

7.0 **Records, Data Analysis, Calculations**

Any project where sampling and analysis is performed shall be executed in accordance with an approved sampling and analysis plan. This procedure may be incorporated by reference or may be incorporated with modifications described in the plan.

Deviations from this procedure or the sampling and analysis plan shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

8.0 **Attachments or References**

- 8.1 ASTM Standard D5088. 2008. *Standard Practice for Decontamination of Field Equipment Used at Waste Sites*. ASTM International, West Conshohocken, PA. 2008. DOI: 10.1520/D5088-02R08. www.astm.org.
- 8.2 NAVSEA T0300-AZ-PRO-010. *Navy Environmental Compliance Sampling and Field Testing Procedures Manual*. August 2009.
- 8.3 Procedure 3-05, *IDW Management*.

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue

Land Surveying

Procedure 3-07

1.0 Purpose and Scope

- 1.1 The purpose of this document is to define the standard operating procedure (SOP) for acquiring land surveying data to facilitate the location and mapping of geologic, hydrologic, geotechnical data, and analytical sampling points and to establish topographic control over project sites.
- 1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).
- 1.3 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review. If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to surface water sampling then those procedures may be added as an appendix to the project specific SAP.
- 1.4 It is fully expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be approved in advance by the Program Quality Manager. Deviations to this SOP will be documented in the field records.
- 1.5 If there are procedures, whether it be from Resolution Consultants, state and/or federal, that are not addressed in this SOP and are applicable to land surveying then those procedures may be added as an appendix to the project specific Sampling and Analysis Plan (SAP).

2.0 Safety

- 2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to conducting fieldwork. All **field sampling personnel** must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the specific field tasks. Conduct preliminary area monitoring to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor and liquid phase through the use of respirators and disposable clothing.
- 2.2 In addition, observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves, rubberized steel-toed boots, and an American National Standards Institute-standard hard hat. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on the contaminant concentrations, and shall always be available on site.
- 2.3 Daily safety briefs will be conducted at the start of each working day before any work commences. These daily briefs will be facilitated by the **Site Safety Officer (SSO)** or designee to discuss the day's events and any potential health risk areas covering every aspect of the work to be completed. Weather conditions are often part of these discussions. As detailed in the HASP, everyone on the field team has the authority to stop work if an unsafe condition is perceived until the conditions are fully remedied to the satisfaction of the SSO.
- 2.4 The health and safety considerations for the work associated with land surveying include:
 - Slip, trips and falls associated with work in the field;

- Biological hazards associated with work in the field; and,
- Potential hazards associated with contaminants of concern (COC) that may be located in the survey area,

3.0 Terms and Definitions

3.1 Boundary Survey

Boundary surveys are conducted by Certified Land Surveyors in order to delineate a legal property line for a site or section of a site.

3.2 Global Positioning System (GPS)

A system of satellites, computers, and receivers that is able to determine the latitude and longitude of a receiver on Earth by calculating the time difference for signals from different satellites to reach the receiver.

4.0 Interferences

- 4.1 Commercially available GPS units typically have a level of precision of (\pm) 3 to 5 meters. Field corrections can be made as described in Section 8.3 below.

5.0 Training and Qualifications

5.1 Qualifications and Training

- 5.1.1 The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 Responsibilities

- 5.2.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that land surveying activities comply with this procedure. The CTO Manager is responsible for ensuring that all field sampling personnel involved in land surveying shall have the appropriate education, experience, and training to perform their assigned tasks.
- 5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 5.2.3 The **Field Manager (FM)** is responsible for ensuring that all field personnel follow these procedures. In virtually all cases, subcontractors will conduct these procedures. The FM or designee is responsible for overseeing the activities of the subcontractor and ensuring that sampling points and topographic features are properly surveyed.

6.0 Equipment and Supplies

- 6.1 The following equipment list contains materials that may be needed in carrying out the procedures outlined in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.
- Personal protective equipment (PPE) and other safety equipment, as required by the HASP;
 - Commercially available GPS unit; and,
 - Field Logbook.

7.0 Calibration or Standardization

- 7.1 An authorized manufacturer's representative shall inspect and calibrate survey instruments in accordance with the manufacturer's specifications regarding procedures and frequencies. At a minimum, instruments shall be calibrated no more than six months prior to the start of the survey work.
- 7.2 Standards for all survey work shall be in accordance with National Oceanic and Atmospheric Administration standards and, at a minimum, with accuracy standards set forth below. The horizontal accuracy for the location of all grid intersection and planimetric features shall be (\pm) 0.1 feet. The horizontal accuracy for boundary surveys shall be 1 in 10,000 feet (1:10,000). The vertical accuracy for ground surface elevations shall be (\pm) 0.1 feet. Benchmark elevation accuracy and elevation of other permanent features, including monitoring wellheads, shall be (\pm) 0.01 feet.

8.0 Procedure

8.1 Theodolite/Electronic Distance Measurement (EDM)

Follow the procedures listed below during theodolite/EDM land surveying conducted under the NAVFAC CLEAN Program:

- A land surveyor registered in the state or territory in which the work is being performed shall directly supervise all surveying work.
- Reference surveys to the local established coordinate systems and base all elevations and benchmarks established on U.S. Geological Survey datum, 1929 general adjustment.
- Reference surveyed points to Mean Sea Level (Lower Low Water Level).
- Jointly determine appropriate horizontal and vertical control points prior to the start of survey activities. If discrepancies in the survey (e.g., anomalous water level elevations) are observed, the surveyor may be required to verify the survey by comparison to a known survey mark. If necessary, a verification survey may be conducted by a qualified third party.
- All field notes, sketches, and drawings shall clearly identify the horizontal and vertical control points by number designation, description, coordinates, and elevations. Map all surveyed locations using a base map or other site mapping, as specified by the project Work Plan or SAP.
- Begin and end all surveys at the designated horizontal and vertical control points to determine the degree of accuracy of the surveys.
- Iron pins used to mark control points shall be made of reinforcement steel or an equivalent material and shall be 18 inches long with a minimum diameter of 5/8 inch. Drive pins to a depth of 18 inches into the soil.
- Stakes used to mark survey lines and points shall be made from 3-foot lengths of 2-inch by 2-inch lumber and pointed at one end. Clearly mark them with brightly colored weatherproof flagging and paint.
- Clearly mark the point on a monitoring well casing or well riser that is surveyed by filing grooves into the casing/riser on either side of the surveyed point, or by marking the riser with a permanent ink marker.

8.2 Global Positioning System (GPS) to Conduct Land Survey

Follow the procedures listed below during land surveying using GPS:

- A land surveyor registered in the state or territory in which the work is being performed shall directly supervise all surveying work.
- Reference surveys to the local established coordinate systems and base all elevations and benchmarks established on U.S. Geological Survey datum, 1929 general adjustment.

- All field notes, sketches, and drawings shall clearly identify the horizontal and vertical control points by number designation, description, coordinates, and elevations. Map all surveyed locations using a base map or other site mapping, as specified in the project Work Plan or SAP.
- Begin and end all surveys at the designated horizontal and vertical control points (as applicable) to determine the degree of accuracy of the surveys.
- Iron pins used to mark control points shall be made of reinforcement steel or an equivalent material and shall be 18 inches long with a minimum diameter of 5/8 inch. Drive pins to a depth of 18 inches into the soil.
- Stakes used to mark survey lines and points shall be made from 3-foot lengths of 2-inch by 2-inch lumber and pointed at one end. Clearly mark them with brightly colored weatherproof flagging and paint.
- Clearly mark the point on a monitoring well casing that is surveyed by filing grooves into the casing on either side of the surveyed point.

8.3 **Global Positioning System (GPS) to Position Sample Locations or Locate Site Features**

Experienced field personnel may use a GPS system unit to position sample locations (e.g. grid positioned samples, soil boring locations) at a site. The decision to use field personnel or a licensed land surveyor will depend on the objectives of the survey (e.g. vertical elevation is not required) and the levels of precision required. Typically when a level of precision greater than (\pm) 3 to 5 meters is required, a licensed surveyor will be required. When a level of precision of (\pm) 3 to 5 meters is sufficient to meet project requirements (i.e. when laying sampling grids, identifying significant site features, or locating features identified in GIS figures) experienced field personnel may use commercially available, consumer-grade GPS units. Follow the procedures listed below to locate samples or site features using GPS:

- A commercially available GPS unit with Wide Angle Averaging System (WAAS), topographic map display, and waypoint storage capabilities should be used.
- If waypoints are to be imported into a GIS database, the same grid projection system should be used.
- If a permanent reference point near the site is available, it is recommended that a waypoint at this location be taken every day waypoints are stored.
- When laying out a sampling grid from a GIS map, upload the coordinates from GIS to the GPS unit, including coordinates for an easily identified, permanent, nearby feature (i.e. building corner, roadway intersection, or USGS benchmark).
- If during the initial site walk, the permanent feature identified does not overlay within (\pm) 5 meters as identified in the GPS unit, field corrections of the waypoints should be made.
- Field corrections can be made by adding/subtracting the difference in x,y coordinates between the field measurement of the permanent site feature and the anticipated x,y coordinates. This correction should then be applied to the x,y coordinates for each sampling location to be marked. Corrected x,y coordinates can then be uploaded into the GPS unit.
- Sampling points and site features can then be located in the field using the GPS units "Go To" function. When the distance to the sampling point or feature remains close to zero, the location can be marked.
- If no field corrections to the sampling location need to be made, or if sampling locations are to be surveyed by a licensed surveyor at a later date, no additional waypoints need to be taken. If significant changes to the sampling location are made, GPS coordinates at the corrected location shall be stored and labeled.

- It is recommended that GPS coordinates be uploaded to a storage device such as PC at the end of each day.
- Field logs shall indicate manufacturer and model number for GPS unit used, map datum and projection used, and any field corrections made. If the GPS unit cannot lock onto a WAAS system at the site, this should also be noted.

9.0 Quality Control and Assurance

None.

10.0 Data and Records Management

The surveyor shall record field notes daily using generally accepted practices. The data shall be neat, legible, in indelible ink, and easily reproducible. Copies of the surveyor's field notes and calculation forms generated during the work shall be obtained and placed in the project files.

Surveyor's field notes shall, at a minimum, clearly indicate:

- The date of the survey;
- General weather conditions;
- The name of the surveying firm;
- The names and job titles of personnel performing the survey work;
- Equipment used, including serial numbers; and,
- Field book designations, including page numbers.

A land surveyor registered in the state or territory in which the work was done shall sign, seal, and certify the drawings and calculations submitted by the surveyor.

Dated records of land surveying equipment calibration shall be provided by the surveyor and placed in the project files. Equipment serial numbers shall be provided in the calibration records.

11.0 Attachments or References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

<i>Author</i>	<i>Reviewer</i>	<i>Revisions (Technical or Editorial)</i>
Robert Shoemaker Senior Scientist	Naomi Ouellette, Project Manager	Rev 0 – Initial Issue

Monitoring Well Installation

Procedure 3-12

1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the methods to be used during the installation of groundwater monitoring wells. It describes the components of monitoring well design and installation and sets forth the rationale for use of various well installation techniques in specific situations.
- 1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

- 2.1 The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the Contract Task Order (CTO) Work Plan (WP) and/or direction from the **Site Safety Officer (SSO)**.
- 2.2 Before well installation commences, appropriate entities (e.g. DigSafe, local public works departments, company facilities) must be contacted to assure the anticipated well locations are marked for utilities, including electrical, telecommunications, water, sewer, and gas.
- 2.3 Physical Hazards Associated with Well Installation
- Stay clear of all moving equipment and avoid wearing loose fitting clothing.
 - When using an approved retractable-blade knife, always cut away from one self and make sure there are no other people in the cutting path or the retractable-blade knife.
 - To avoid slip/trip/fall conditions during drilling activities, keep the area clear of excess soil cuttings and groundwater. Use textured boots/boot cover bottoms in muddy areas.
 - To avoid heat/cold stress as a result of exposure to extreme temperatures and personal protective equipment (PPE), drink electrolyte replacement fluids (1 to 2 cups per hour is recommended) and, in cases of extreme cold, wear fitted insulating clothing.
 - To avoid hazards associated with subsurface utilities, ensure all sampling locations have been properly surveyed as described in SOP 3-01, Utility Clearance.
 - Be aware of restricted mobility caused by PPE.

3.0 Terms and Definitions

- 3.1 **Annulus:** The annulus is the down-hole space between the borehole wall and the well casing and screen.
- 3.2 **Bridge:** A bridge is an obstruction in the drill hole or annulus. A bridge is usually formed by caving of the wall of the well bore, by the intrusion of a large boulder, or by the placement of filter pack materials during well completion. Bridging can also occur in the formation during well development.
- 3.3 **Filter Pack:** Filter pack is sand or gravel that is smooth, uniform, clean, well-rounded, and siliceous. It is placed in the annulus of the well between the borehole wall and the well screen to prevent formation materials from entering the well and to stabilize the adjacent formation.
- 3.4 **Grout:** Grout is a fluid mixture of cement and water that can be forced through a tremie pipe and emplaced in the annular space between the borehole and casing to form an impermeable seal. Various additives, such as sand, bentonite, and polymers, may be included in the mixture to meet certain requirements.
- 3.5 **Heaving (Running) Sands:** Loose sands in a confined water-bearing zone or aquifer which tend to rise up into the drill stem when the confining unit is breached by the drill bit. Heaving sands occur when the water in the aquifer has a pressure head great enough to cause upward flow into the drill stem with enough velocity to overcome the weight of the sand.
- 3.6 **Sieve Analysis:** Sieve analysis is the evaluation of the particle-size distribution of a soil, sediment, or rock by measuring the percentage of the particles that will pass through standard sieves of various sizes.

4.0 Interferences

- 4.1 Heaving sands may be problematic in unconsolidated sands encountered below the water table.
- 4.2 Rotary drilling methods requiring bentonite-based drilling fluids should be used with caution to drill boreholes that will be used for monitoring well installation. The bentonite mud builds up on the borehole walls as a filter cake and permeates the adjacent formation, potentially reducing the permeability of the material adjacent to the well screen.
- 4.3 If water or other drilling fluids have been introduced into the boring during drilling or well installation, samples of these fluids should be obtained and analyzed for chemical constituents that may be of interest at the site. In addition, an attempt should be made to recover the quantity of fluid or water that was introduced, either by flushing the borehole prior to well installation and/or by overpumping the well during development.
- 4.4 Track-mounted drill rigs are suitable for travelling on many types of landscapes that truck-mounted units cannot access, but may have limitations on extremely uneven or soft terrain.
- 4.5 Care should be taken to prevent cross-contamination between well locations. All drilling equipment coming in contact with potentially contaminated soil and/or groundwater will be decontaminated by the drilling subcontractor prior to initial drilling activities and between drilling locations in accordance with SOP 3-06, Equipment Decontamination.

5.0 Training and Qualifications

5.1 Qualifications and Training

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 Responsibilities

- 5.2.1 **Contract Task Order (CTO) Managers** are responsible for issuing sampling and analysis plans (SAPs) that reflect the procedures and specifications presented in this procedure. Individual municipalities, county agencies, and possibly state regulatory agencies enforce regulations that may include well construction and installation requirements. The **CTO Manager** shall be familiar with current local and state regulations, and ensure that these regulations are followed. The **CTO Manager** is responsible for ensuring that all personnel involved in monitoring well installation shall have the appropriate education, experience, and training to perform their assigned tasks.
- 5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 5.2.3 The **Field Manager** is responsible for direct supervision of the installation of monitoring wells and ensuring that procedures and specifications are implemented in the field in accordance with the approved SAP and well installation permits. The qualifications for the **Field Manager** must be in accordance with local jurisdictions with authority over the operations conducted.
- 5.2.4 All field personnel are responsible for the implementation of this procedure.
- 5.2.5 The on-site hydrogeologist/engineer is expected to obtain a description of the lithologic samples obtained during the excavation and construction of a monitoring well. These data are often required to provide guidance regarding the installation of specific components of the monitoring well. Guidance for lithologic sample collection and sample description is contained within SOP 3-16, Soil and Rock Classification.

6.0 Equipment and Supplies

6.1 Materials provided by the drilling contractor may include:

- Drill rig, drill rods, hollow stem augers, etc.
- Decontamination equipment (e.g., steam cleaner, high-pressure washer, brushes, etc.)
- Decontamination pad materials
- Well screen/riser pipe with flush-threaded couplings including riser and bottom caps
- Clean, filter sand
- Bentonite chips or pellets
- Cement grout and tremie pipe
- Portland cement for well pad completion
- Steel protective riser covers and locking caps
- Weighted calibrated tape
- Split-spoon samplers
- 55-gallon drums or containers for drill cuttings, decontamination fluids, etc.

6.2 In addition to those materials provided by the drilling contractor, equipment and materials required by the project geologist/engineer may include, but is not limited to, the following:

- Photoionization Detector (PID)
- Spill kit, including at a minimum sorbent pads and shovel (if not provided by subcontractor)

- Plastic sheeting
- Teaspoon or spatula
- Resealable plastic bags
- Boring Log Records
- Decontamination materials (per SOP No. 3-06 - Equipment Decontamination)
- Weighted measuring tape for depth measurement
- Soil logging materials (e.g. USCS classification field card, millimeter rule, hand lens, etc.)
- Survey lathes or pin flags
- Digital camera
- PPE as required by the HASP
- Planning documents including the site-specific HASP and SAP
- Large indelible ink or paint pen
- Field logbook/field forms/site maps (water proof)

7.0 Procedure

7.1 General Procedures

- Specific drilling, sampling, and installation equipment and methodology will be dictated by the type of well to be installed (e.g., single case (Type II), double case (Type III), bedrock, etc.), geologic characteristics of the site, the type of contaminants being monitored, and local and state regulations.
- For access to locations when travelling over difficult terrain, an appropriate line should be chosen before mobilizing the drill rig or other support vehicles. If clearing of trees or ground cover is required, perform these activities in advance to avoid down time. Avoid wet or soft areas where possible or use ground mats and/or timbers to aid in supporting the rig as it travels. If drilling on soft material, place geomatting and ground mats under the rig tracks or stabilizers prior to drilling.
- A utility locate must be conducted to identify all underground utilities at the site prior to drilling (refer to SOP 3-01, Utility Clearance). Proper clearance procedures for aboveground/overhead utilities must also be followed as specified in the HASP.
- Although new well materials (well screen and riser pipe) generally arrive at the site boxed and sealed within plastic bags, it is sometimes necessary to decontaminate the materials prior to their use. Well materials should be inspected by the project geologist/engineer upon delivery to check for cleanliness. If the well materials appear dirty, or if local or regional regulatory guidance requires decontamination, then well material decontamination should be performed by the drilling subcontractor in accordance with SOP 3-06, Equipment Decontamination.
- The diameter of the borehole must be a minimum of 2 inches greater than the outside diameter of the well screen or riser pipe used to construct the well. This is necessary so that sufficient annular space is available to install filter packs, bentonite seals, and grout seals, and allow the passage of tremie pipe where grouting at depth is required. Bedrock wells may require reaming after coring in order to provide a large enough borehole diameter for well installation.
- When soil sampling is required (refer to the SAP), soil samples will be collected for visual logging by advancing split-spoon samplers through the augers. The soil will be visually logged by a field geologist and include lithologic characteristics (i.e., soil type, color, density, moisture content, etc.) using the the

methods described in SOP 3-16, Soil and Rock Classification. This information will be recorded on a boring/well log form, along with well construction details.

7.2 Drilling Techniques

Drilling of monitoring well boreholes may be accomplished by a variety of methods as described below. Preferred methods include those that temporarily case the borehole during drilling (i.e., hollow stem auger and sonic methods) using an override system. Other methods can be used where specific subsurface conditions or well design criteria dictate.

- Hollow stem auger (HSA) – Borings are advanced by rotating steel hollow stem augers with an attached cutting head. Soil cuttings are displaced by the cutting head and transported to the surface via continuous spiral flights attached to each auger stem. This method is widely used for unconsolidated soils that have a tendency to collapse within the boring. A bottom plug can be placed in the bottom auger to prevent soils from entering and clogging the auger, especially in the case of heaving sands. However, a bottom plug cannot be used when soil samples are to be collected through the augers. Soil plugs that accumulate in the bottom of the auger must be removed or knocked out prior to sampling or well installation.
- Solid stem auger – This type of drilling method is similar to HSA drilling using a solid stem or sealed hollow stem auger flights to advance the boring. Solid stem, continuous flight auger use is limited to semi-consolidated sediments or to cohesive or semi-cohesive unconsolidated sediments that don't have a tendency to collapse when disturbed.
- Sonic methods – Sonic drilling consists of advancing concentric hollow drill casings (inner and outer) using rotation in conjunction with axial vibration of the drill casing. Once the casings are advanced to the appropriate depth, the inner string is removed with a core of drill cuttings while the outer casing remains in place to keep the borehole open. Cuttings are removed from the inner casing relatively intact for logging or sampling purposes. This drilling method is used for a variety of soil types, from heaving sands to consolidated or indurated formations. Smearing of the formation along the borehole walls is minimal since moderate vibration and rotation techniques are used to advance the casings. Since the total borehole diameter in sonic drilling is only incrementally larger than the inner casing diameter, care should be taken during installation of the monitoring well to ensure the well is centered and adequate space is available for annular materials.
- Rotary methods (water or mud) – Rotary drilling methods consist of drill rods coupled to a drill bit that rotates and cuts through the soils to advance the borehole. Water or drilling fluid ("mud") is forced through the hollow drill rods and drill bit as the rods are rotated. The soil cuttings are forced up the borehole with the drilling fluids to the surface and the fluids recirculated. The drilling fluid provides a hydrostatic pressure that reduces or prevents the borehole from collapsing. Clean, potable water must be used for water-rotary drilling to prevent introducing trace contaminants. A sample of the potable water should be collected during the course of well installation for analysis of the same parameters defined for the groundwater samples. If mud-rotary is used to advance boreholes, potable water and bentonite drilling mud should only be used. No chemical additives shall be mixed in the drilling fluid to alter viscosity or lubricating properties. Adequate well development is essential for removal of drilling mud and fluids from the formation materials and ensure collection of representative groundwater samples.
- Rotary methods (Air) – Air rotary methods are similar to water rotary but use high air velocities in place of drilling fluids to rotate the drill bit and carry the soil cuttings up the borehole to the surface. Care must be taken to ensure that contaminants are not introduced into the air stream from compressor oils, etc. Most compressor systems are compatible with a coalescing filter system. Cuttings exiting the borehole under pressure must be controlled, especially when drilling in a zone of potential contamination. This can be accomplished by using an air diverter with hose or pipe to carry the cuttings to a waste container. Letting the cuttings blow uncontrolled from the borehole is not acceptable.

7.3 Well Construction and Installation

- If rotary drilling techniques are used, the borehole should be flushed or blown free of material prior to well installation. If hollow stem augers are used, the soil or bottom plug should be removed and the augers raised approximately six inches above the bottom of the borehole, while slowly rotating the augers to remove cuttings from the bottom of the boring. The depth of the borehole should be confirmed with a weighted, calibrated tape.
- The riser pipe and screen should be connected with flush-threaded joints and assembled wearing clean, disposable gloves. No solvent or anti-seize compound should be used on the connections. The full length of the slotted portion of the well screen and unslotted riser pipe should be measured and these measurements recorded on a well construction form (Attachment 1).
- If placed in an open borehole, the assembled well should be carefully lowered and centered in the borehole so that the well is true, straight, and vertical throughout. Centering can also be accomplished with the use of centralizers, if necessary. However, centralizers should be placed so that they do not inhibit the installation of filter sand, bentonite seal, and annular grout. Wells less than 50 deep generally do not require centralizers.
- If hollow stem augers are used, the well should be lowered through the augers and each auger flight removed incrementally as the filter sand, bentonite seal, and grout are tremmied or poured into the annular space of the well. The well should be temporarily capped before filter sand and other annular materials are installed.
- Clean, silica sand should be placed around the well screen to at least 1 foot above the top of the screen. The filter sand should be appropriately graded and compatible with the selected screen size and surrounding formation materials. In general, the filter pack should not extend more than 3 feet above the top of the screen to limit the thickness of the monitoring zone. As the filter pack is placed, a weighted tape should be lowered in the annular space to verify the depth to the top of the layer. This measurement will be recorded on the well construction form (Attachment 1). If necessary, to eliminate possible bridging or creation of voids, placement of the sand pack may require the use of a tremie pipe. Tremie pipe sandpack installations are generally suggested for deeper wells and for wells which are screened some distance beneath the water table.
- A minimum 2-foot thick layer of bentonite pellets or slurry seal will be installed immediately above the filter sand to prevent vertical flow within the boring from affecting the screened interval. Bentonite chips/pellets must be hydrated if placed above the water table prior to grouting. If bridging is of concern as in the case of deep wells, powdered bentonite may be mixed with water into a very thick slurry and a tremie pipe used to place the seal to the desired depth. Placement of the bentonite seal in the borehole will be recorded on the well construction form (Attachment 1).
- The remaining annular space around the well will be grouted from the top of the bentonite seal to the surface with a grout composed of neat cement, a bentonite cement mixture, or high solids sodium bentonite grout.
- Each well riser will be secured with an expandable, locking cap (vented if possible). Optionally, a hole can be drilled in the upper portion of the riser to allow venting of the well.
- The well will be completed within a concrete well pad consisting of a Portland cement/sand mixture. Well pads are generally 3 feet by 3 feet square but may be larger or smaller depending on site conditions and state-specific well construction standards. Round concrete well pads are also acceptable. A minimum of 1 inch of the finished pad should be below grade to prevent washing and undermining by soil erosion.
- If completed as a flush-mount well, the well riser will be cut off approximately 4 to 6 inches below ground surface and an expandable, locking cap placed on the well riser. The area around the riser is dug out and a steel well vault or manhole cover placed over the riser and set almost flush to the ground.

to protect the well. The manhole cover should be water-tight and secured with bolts to prevent casual access. The well pad will then be constructed around the well vault and slightly mounded at the center and sloping away to prevent surface water from accumulating in the well vault.

- If completed as a stick-up well, the well riser is cut approximately 2.5 to 3 feet above the ground surface and an expandable, locking cap placed on the well riser. A steel guard pipe with hinged, locking cap is placed over the well riser as a protective casing. The bottom of the guard pipe will be set approximately 2 feet below ground surface and sealed by pouring concrete from the top of the annular grout around the pipe to grade. The concrete well pad should be completed at the same time. Weep holes will be drilled in the base of the guard pipe to facilitate draining of rainwater or purge water from inside the guard pipe.
- Bumper posts or bollards may be necessary for additional well protection, especially in high traffic areas. The bumper posts should be placed around the well pad in a configuration that provides maximum protection to the well and extend a minimum of 3 feet above the ground.

7.4 Double Cased Wells

Under certain site conditions, the use of a double-cased or telescoping (Type III) well may be necessary. Installation of double-cased wells may be required to prevent the interconnection of two separate aquifers, seal off a perched aquifer without creating a vertical hydraulic conduit, prevent cross-contamination during construction of wells in deeper aquifers hydro-stratigraphically below impacted aquifers, or case off highly impacted soils present above the aquifer to prevent potential "dragging down" of contaminants.

Similar to conventional wells, construction of double-cased wells can be accomplished using a variety of drilling methods. Well construction is initiated by "keying" a large diameter, outer casing into a stratigraphic zone of low permeability (clay layer or bedrock). The size of the outer casing should be a minimum of 2 inches greater than the outside diameter of the inner casing to allow installation of annular seal materials during well completion. A pilot borehole should be drilled through the overburden soil and/or contaminated zone into a clay confining layer or bedrock. The borehole for the outer casing should be of sufficient size to contain the outer casing with a minimum of 2 inches around the outside diameter to allow sufficient annular space for tremie or pressure grouting. The boring should extend a minimum of 2 feet into a clay layer and a minimum of 1 foot into bedrock, if possible, to ensure an adequate seal. The boring should never breach a confining layer or keyed zone under any circumstances.

Once the boring is completed, the outer casing can be set in the borehole and sealed with grout. The outer casing can be set two ways, with or without a bottom cap. If no bottom cap is applied, the casing is usually driven approximately 6 inches into the clay confining unit. A grout plug is generally placed in the bottom of the casing and once set, standing water in the casing is evacuated prior to drilling below the casing. As an alternative, a cap can be placed on the bottom of the casing and if set below the water table, the casing can be filled with clean, potable water to hold down the casing in the boring. Grouting should be conducted using tremie-grouting or pressure-grouting methods by pumping grout into the annular space between the outer casing and the borehole wall from the bottom of the casing to the ground surface. Grout around the casing should be allowed to cure at least 24 hours before attempting to drill through the bottom.

Once the grout is cured, a smaller diameter drill pipe/bit is used to bore through the grout plug or bottom cap to the desired well depth. The well is then constructed as described in Section 7.3 above.

7.5 Post Installation Procedures

- Wells should be permanently labelled or marked for identification. Well tags can be used to record the site name, well number, total depth, installation date, etc. At a minimum, the well number will be written in indelible marker or paint on both the outside of the protective casing and inside beneath the casing lid, as well as on the riser pipe.

- A measuring point will be marked on the top of the riser pipe for taking water level measurements. The measuring point can be notched using a knife or saw or can be marked with a waterproof marker or paint. The measuring point will also be the point which will be surveyed for vertical elevation data.
- Upon completion, the following measurements will be taken by the field geologist/engineer and recorded on the well construction diagram.
 - Depth to static water level
 - Depth of non-aqueous phase liquid (NAPL), if present
 - Total depth of well measured from top of casing (TOC)
 - Height of well casing above ground surface
 - Height of protective casing above ground surface
- All monitoring wells will be surveyed for horizontal and vertical control by a licensed surveyor.
- Investigation-derived waste (IDW) including drill cuttings, spent materials (e.g., PPE), and decontamination water should be properly managed in accordance with SOP 3-05, IDW Management.

8.0 Quality Control and Assurance

- 8.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the SAP. Certain quality control (QC) measures should be taken to ensure proper well installation and construction in accordance with this SOP, project specific SAP, and applicable well standards.
- 8.2 The borehole will be checked for total open depth, and extended by further drilling or shortened by backfilling, as required before installation of the well materials.
- 8.3 Water level and NAPL presence will be checked during well installation to ensure that the positions of well screen, filter sand, and seals relative to water level conform to project requirements
- 8.4 The depth to top of each layer of annular materials (i.e., filter sand, bentonite, grout) will be verified and adjusted as necessary for proper placement.

9.0 Records, Data Analysis, Calculations

All field information will be recorded in the field logbook and/or standardized field forms by field personnel. Field data recorded will include drilling contractor information, drilling methods, well material and construction information provided on the boring logs and well construction forms, observations or problems encountered during drilling, fluid level data, and any deviations from the procedures in this SOP and other project plans. Well Construction Forms (Attachment 1) will provide visual and descriptive information the monitoring well and are often the most critical form of documentation generated during the installation of a monitoring well. The field logbook is kept as a general log of activities and should not be used in place of the boring log.

10.0 Attachments or References


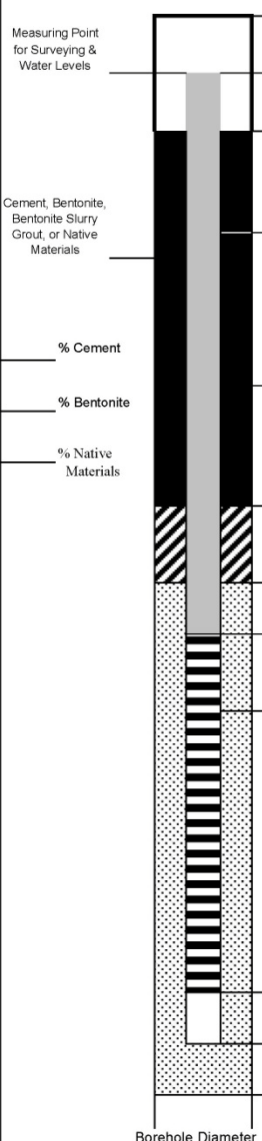
- 10.1 Attachment 1 – Monitoring Well Construction Form

- 10.2 Environmental Protection Agency, United States (EPA). 1987. *A Compendium of Superfund Field Operations Methods*. Office of Solid Waste and Emergency Response. EPA/540/P-87/001.
- 10.3 EPA. 1990. *Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells*. EPA/600/4-89/034. Office of Research and Development, Washington. March.
- 10.4 EPA. 1992. *RCRA Groundwater Monitoring Draft Technical Guidance*. EPA/530/R-93/001. Office of Solid Waste. November.
- 10.5 EPA, 2008. SESD Operating Procedure SESDGUID-101-R0: *Design and Installation of Monitoring Wells*. USEPA, Science and Ecosystem Support Division (SESD), Athens, Georgia. Effective Date February 18, 2008.
- 10.6 U.S. Army Corps of Engineers. 2008. Manual No. EM 385-1-1. *Safety and Health Requirements*. 15 November 2008. http://140.194.76.129/publications/eng-manuals/em385-1-1/2008_English/toc.html.
- 10.7 SOP 3-01, *Utility Clearance*.
- 10.8 SOP 3-05, *IDW Management*
- 10.9 SOP 3-06, *Equipment Decontamination*.
- 10.10 SOP 3-16, *Soil and Rock Classification*.

<i>Author</i>	<i>Reviewer</i>	<i>Revisions (Technical or Editorial)</i>
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

Attachment 1

Monitoring Well Construction Form

	Client: _____		WELL ID: _____
	Project Number: _____		
	Site Location: _____		
	Well Location: _____	Coords: _____	
	Method: _____		
MONITORING WELL CONSTRUCTION DETAIL			
		Depth from G.S. (feet)	Elevation(feet) Datum _____
	Top of Steel Guard Pipe	_____	_____
	Top of Riser Pipe	_____	_____
	Ground Surface (G.S.)	0.0	_____
	Riser Pipe:		
	Length _____		
	Inside Diameter (ID) _____		
	Type of Material _____		
	Bottom of Steel Guard Pipe		
	Top of Bentonite	_____	_____
	Bentonite Seal Thickness _____		
	Top of Sand	_____	_____
	Top of Screen	_____	_____
	▼ Stabilized Water Level	_____	_____
	Screen:		
	Length _____		
Inside Diameter (ID) _____			
Slot Size _____			
Type of Material _____			
Type/Size of sand _____			
Sand Pack Thickness _____			
Bottom of Screen	_____	_____	
Bottom of Tail Pipe:			
Length _____			
Bottom of Borehole	_____	_____	
Borehole Diameter _____		Approved: _____	
Describe Measuring Point: _____		Signature _____ Date _____	

Monitoring Well Development

Procedure 3-13

1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the procedures used for developing newly installed monitoring wells and/or redeveloping existing wells.
- 1.2 The purpose of well development is to remove interferences from a well to provide better connection between the well and the formation, to improve pumping performance of the well, and to be able to collect more representative information from the well (e.g., samples, test results, etc.). Proper well development will:
- Remove drilling residuals (e.g., water, mud) from the borehole and surrounding formations;
 - Improve or restore hydraulic conductivity of the surrounding formations which may have been disturbed during the drilling process;
 - Remove residual fines from the well screen and sand pack (filter pack) materials, thus reducing turbidity of groundwater and permitting the collection of more representative groundwater samples.
- 1.3 There may be circumstances where well development is not desirable, for example, in the presence of non-aqueous phase liquids (NAPL) or other significant contamination if development could worsen the contaminant impact. If NAPL begins to intrude during development, the development process will be halted. This situation will be considered a cause for sample modification requiring approval by the CTO Manager and other stakeholders, as applicable.
- 1.4 The applicable well development procedures for a particular site may be subject to State or local regulatory requirements. In all cases, the project team should consult their local regulatory requirements and document the selected well development procedure in the project-specific Sampling and Analysis Plan (SAP). For project-specific information refer to the SAP, which takes precedence over these procedures.
- 1.5 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).
- 1.6 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

- 2.1 The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the Contract Task Order (CTO) SAP and/or direction from the Site Safety Officer (SSO).
- 2.2 Monitoring well development may involve chemical hazards associated with potential contaminants in the soil or aquifer being characterized and may involve physical hazards associated with use of well development equipment.

3.0 Terms and Definitions

None.

4.0 Interferences

- 4.1 Equipment/materials used for development may react with the groundwater during development. Appropriate development equipment has been selected for the anticipated condition of the groundwater.
- 4.2 Appropriate development methods such as using a surge-block to flush suspended fines in the groundwater in and out of the well screen can improve the yield of wells and improve their potential to be developed successfully. However, the effectiveness of development can be significantly reduced in wells that do not yield sufficient water to allow this flushing to take place.
- 4.3 For formations with a significant content of fine-grained materials (silts and clays), or wells with improperly sized screens, it may not be possible to reduce turbidity to commonly acceptable levels. Possible solutions may include collecting a sample even if excessively turbid, or installing a replacement well.
- 4.4 Development itself disturbs the surrounding formation and disrupts equilibrium conditions within the well. Groundwater samples will not be collected until a minimum of 24 hours after a well is developed to allow conditions to stabilize. For sites with fine-grained formations (silts and clays) and highly sorptive contamination, a longer time period between development and sampling should be considered.

5.0 Training and Qualifications

5.1 Qualifications and Training

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 Responsibilities

- 5.2.1 The **CTO Manager** is responsible for ensuring that well development activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all personnel involved in well development shall have the appropriate education, experience, and training to perform their assigned tasks.
- 5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 5.2.3 The **Field Manager** is responsible for ensuring that all well development activities are conducted according to either this procedure or the applicable procedure presented in the project-specific SAP.
- 5.2.4 **Field sampling personnel** are responsible for the implementation of this procedure.
- 5.2.5 The field sampler and/or task manager is responsible for directly supervising the well development procedures to ensure that they are conducted according to this procedure and for recording all pertinent data collected during sampling.

6.0 Equipment and Supplies

- 6.1 This equipment list was developed to aid in field organization and should be used in planning and preparation. Depending on the site-specific requirements and the development method selected, additional or alternative material and equipment may be necessary. In addition, for sites where groundwater is expected to be contaminated, the materials to be placed down the well and in contact with groundwater should be evaluated so that they are compatible with the chemical conditions expected in the well.
- 6.2 Equipment and materials used for well development may include, but is not limited to:

Well development equipment

- Surge block

- Disposable Teflon bailers, appropriate to the diameter of the well(s): 1-inch to 1.5-inch for 2-inch inside diameter (ID) monitoring wells.
- Watterra® footvalve
- Electric submersible pump
- 12-volt power source for electric pump
- High density polyethylene (HDPE) tubing appropriately sized for Watterra® footvalve and/or electric submersible pump
- Drums or containers for storage of purge water
- Nephelometer to measure turbidity
- Multi-parameter water quality meter(s) to measure temperature, pH, conductivity, dissolved oxygen (DO), oxidation reduction potential (ORP)
- Instrument calibration solutions
- Water level meter
- Oil/water interface probe

General equipment

- Project-specific plans including the site-specific HASP and SAP
- Field notebook/field forms/site maps
- Indelible markers/pens
- 5-gallon buckets

Equipment decontamination supplies (refer to SOP 3-06, Equipment Decontamination)

- Health and safety supplies, including personal protective equipment (PPE)
- Appropriate hand tools
- Keys or combinations to access monitoring wells
- Distilled/deionized water supply
- Disposable bailer string (polypropylene)
- Plastic trash bags

7.0 Procedure

Development generally consists of removing water and entrained sediment from the well until the water is clear (to the extent feasible) and the turbidity is reduced, which indicates the well is in good hydraulic connection with the surrounding formation. In addition to simply removing water, development can be improved when flushing through the well screen and gravel pack takes place in both directions, that is, both into the well and into the formation. This action breaks down sediment bridges that can occur in the formation or sand pack, which reduce the connection between the well and the formation

7.1 General Preparation

- All down-well equipment should be decontaminated prior to use and between well locations in accordance with SOP 3-06, Equipment Decontamination
- Although equipment is decontaminated between well locations, if wells are known or suspected to be contaminated based on observations during well installation, it is recommended that well development be conducted in order from the least contaminated to the most contaminated well to minimize the chances of cross-contamination.
- Management of investigation-derived waste (IDW), including development purge water and miscellaneous expendable materials generated during the development process, will be conducted in accordance with SOP 3-05, IDW Management.

- Prior to accessing the well, the wellhead should be cleared of debris and/or standing water. Nothing from the ground surface should be allowed to enter the well.
- The depth to water and total well depth should be measured with a water level meter and recorded in the field logbook or on a Well Development Record (Attachment 1). This information will be used to calculate the volume of standing water (i.e., the well volume) within the well, and plan the specific details of the well development. If wells are suspected to contain NAPL, an oil/water interface probe should be used to measure liquid levels and depth to bottom of the well.
- Permanent monitoring wells will be developed no sooner than 24 hours after well installation is completed in order to allow well completion materials to set properly.

7.2 Monitoring Well Development Procedures

Generally, development will begin by gently surging the well with a surge block or bailer as described in Sections 7.2.1 and 7.2.2, respectively. Surging can become more vigorous as development progresses but initially the well must be gently surged to allow material blocking the screen to become suspended without damaging the well. Next, a bailer can be used to remove the sediment settled at the base of the well. A bailer, Watterra[®] pump, or electric submersible pump will then be used to purge the well, per Sections 7.2.2, 7.2.3, or 7.2.4, respectively. The well will be purged until the removed water becomes less turbid or per the requirements of the project-specific SAP, or State or local requirements. At this point the well will be surged again with a surge block or bailer. The well can be surged more vigorously at this point. After surging, the well will be purged again until the turbidity once again decreases. The surge/purge cycle should be completed at least three times during the development process. After the last surge, the well will be purged until the development completion criteria outlined in 7.3.2 or per the project-specific SAP are met.

7.2.1 Surge Block

The default method of well development is the use of a surge block in conjunction with pumping or bailing to remove sediment-laden water.

- The construction of the surge block must be appropriate for the diameter of the well. The surge block must be mounted on rods or other stiff materials to extend it to the appropriate depths and to allow for the surge block to be moved up and down in the well.
- Insert the surge block into the well and lower it slowly to the screened or open interval below the static water level. Start the surge action by slowly and gently moving the surge block up and down in the well. A slow initial surging, using plunger strokes of approximately 1 meter or 3 feet, will allow material which is blocking the screen to separate and become suspended.
- After 5 to 10 plunger strokes, remove water from the well using a separate bailer (Section 7.2.2) or pumping techniques (Sections 7.2.3 or 7.2.4). The returned water should be heavily laden with suspended fines. The water will be discharged to 5-gallon buckets or 55-gallon drums to be managed per the requirements presented in the project-specific SAP.
- In some cases, the bailer or Watterra[®] foot valve can act as a surge block, flushing water in and out of the well screen as groundwater is removed.
- Repeat the process of surging and pumping/bailing. As development continues, slowly increase the depth of surging to the bottom of the well screen. Surging within the riser portion of the well is neither necessary nor effective.

7.2.2 Bailer

- Tie a string or other cable securely to the bailer. Lower it to the screened or open interval of the monitoring well below the static water level.
- The bailer may be raised and lowered repeatedly within the screened interval to attempt to simulate the action of a surge block by pulling fines through the well screen, and pushing water out into the formation to break down bridging.

- With the bailer full of water, remove it from the well and discharge the water into 5-gallon buckets or 55-gallon drums to be managed per the requirements presented in the project-specific SAP.
- The Watterra® system (Section 7.2.3) or electric submersible pump (Section 7.2.4) may be used as a complementary development method to the bailer, especially when removal of additional water at a faster rate is beneficial.
- Continue alternately surging and bailing, monitoring the purge water periodically (Section 7.3.1) until development completion criteria are met (Section 7.3.2).

7.2.3 Watterra® system

- Attach high-density polyethylene (HDPE) tubing to the decontaminated Watterra® pump foot valve
- Lower the foot valve and tubing assembly near the bottom of the well.
- Lift and lower the tubing to allow water to enter the Watterra® foot valve and travel up the tubing and discharge the water into 5-gallon buckets or 55-gallon drums to be managed per the requirements presented in the project-specific SAP.
- The lifting and lowering action of the Watterra® system will cause some surging action to aid in breaking up fine material in the surrounding formation.
- A bailer (Section 7.2.2) may be used as a complementary development method to the Watterra® system, especially during the initial stages of development when a high volume of sediment may be required to be removed.
- An electric submersible pump (Section 7.2.4) may also be used as a complementary development method to the Watterra® system, especially when more volume of water is desired to be pumped or the turbidity criteria cannot be met due to the surging action of the Watterra® system.
- Continue alternately surging and pumping, monitoring the purge water periodically (Section 7.3.1) until well development completion criteria are met (Section 7.3.2).

7.2.4 Electric Submersible Pump

- Attach HDPE tubing to the decontaminated electric submersible pump.
- Lower the pump and tubing assembly near the bottom of the well, at least a few inches above the well total depth.
- Begin pumping, discharging the water into 5-gallon buckets or 55-gallon drums to be managed per the requirements presented in the project-specific SAP.
- Continue alternately surging and pumping, monitoring the purge water discharge periodically (Section 7.3.1) until well development completion criteria are met (Section 7.3.2).

7.3 Discharge Monitoring

7.3.1 Monitoring the Progress of Development

The progress of the development is evaluated through visual observation of the suspended sediment load and measurement of the turbidity and other parameters in the purged discharge water. As development progresses, the water should become clearer, measured turbidity should decrease, and specific capacity (pumping rate divided by drawdown) should stabilize. Water quality parameters, including DO, conductivity, ORP, pH, temperature, and turbidity may be measured and recorded periodically to determine the progress of development using the criteria outlined in Section 7.3.2 or per the project-specific SAP. Water quality parameters should be measured on each well volume removed.

7.3.2 Completion of Development

The well will be considered developed when the following criteria are met or per the criteria set forth in the project-specific SAP:

- A minimum of three times the standing water volume in a well (to include the well screen and casing plus saturated annulus, assuming 30 percent porosity) is removed.

- Groundwater parameters for three consecutive standing water volumes are within the following:
 - pH – within ± 0.2 units
 - Specific conductivity – within $\pm 3\%$
 - ORP – within ± 10 mV
 - Temperature – within ± 1 degree Celsius
 - Turbidity – at or below 10 nephelometric turbidity units (NTU) or within $\pm 10\%$ if above 10 NTU.
- The sediment thickness remaining within the well is less than 1 percent of the screen length or less than 30 millimeters (0.1 ft) for screens equal to or less than 10 feet long.

Dissolved oxygen (DO) readings may be recorded but DO readings will not be used as development completion criteria because DO may not stabilize.

If the well has slow groundwater recharge and is purged dry, the well will be considered developed when bailed or pumped dry three times in succession and the turbidity has decreased, or per the requirements set forth in the project-specific SAP. Water quality parameters may be recorded if feasible using the flow-through cell.

If any water is added to the well's borehole during development or drilling, three times the volume of water added will also be removed during well development, or per the requirements set forth in the project-specific SAP.

7.4 Development of Wells with Low Yield

Water is the primary mechanism to remove fines and flush water through the gravel pack for effective development. Therefore, development can be a challenge in wells that do not yield sufficient water to recharge when water is removed. However, often these wells are the most in need of development to improve their performance as they are typically installed in low permeability formations with a high content of fines. Development of these wells can improve their yield.

The surging portion of the development can be successfully performed in a well with standing water regardless of its yield. It is the subsequent removal of fine materials that is hindered when insufficient water is recharged to the well. When wells go dry or drawdown significantly during development, development can be performed intermittently, allowing sufficient water to recharge prior conducting the next stage of surging. These intermittent procedures can take place hours or even days apart, depending on project-specific time constraints.

7.5 Wells containing NAPL

Additional care should be taken when planning development of wells that contain NAPL. If the NAPL is flammable, there are health and safety as well as handling issues to consider. If NAPL in excess of a persistent sheen is noted, the recharge rate will be evaluated through hand bailing. In most cases, it is generally preferable to remove NAPL by bailing to the extent practical prior to performing development. Groundwater parameters, excluding turbidity, will not be collected during well development if NAPL or excessive sheen is noticed in the purged water during development to ensure the meter probes are not fouled or destroyed. Well development will be halted.

Development by surging or pumping the well dry can result in the spreading of NAPL vertically in the soil column around the well. These methods can be used, if information exists describing the vertical thickness of the NAPL smear zone around the well, and if the methods do not result in mounding or drawdown that exceeds this thickness. Alternate methods such as bailing may also be used, but any method should not allow the well to be pumped dry or result in significant drawdown that would spread the NAPL vertically.

7.6 Temporary Well Points

For certain projects, temporary well points (TWPs) may be installed to collect groundwater samples at a site. Since no sand pack, bentonite chips, or bentonite grout are generally used in the construction of the TWPs, development can proceed as soon as sufficient water has entered the well to static conditions. Due to the small diameter of these wells, generally ¾-inch to 1-inch ID, development will be performed using either a small diameter (0.5-inch) bailer and/or a peristaltic pump with dedicated tubing. The TWPs will have minimal water column and may purge dry during development. However, attempts will be made to remove fines from the well prior to sampling. Purging and sampling may occur as soon as approximately 80% of the static water has re-entered the TWP, or per the requirements set forth in the project-specific SAP.

8.0 Quality Control and Assurance

- 8.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the project-specific SAP.
- 8.2 Quality control (QC) requirements are dependent on project-specific sampling objectives. The project-specific SAP will provide requirements for equipment decontamination (frequency and materials) and IDW handling.

9.0 Records, Data Analysis, Calculations

- 9.1 All data and information (e.g., development method used) must be documented on field data sheets (Attachment 1) or within site logbooks with permanent ink. Data recorded may include the following:
- Well Location
 - Weather conditions
 - Date and Time
 - Purge Method
 - Reading/measurements obtained

10.0 Attachments or References

Attachment 1 – Well Development Record

SOP 3-05, *IDW Management*.

SOP 3-06, *Equipment Decontamination*.

<i>Author</i>	<i>Reviewer</i>	<i>Revisions (Technical or Editorial)</i>
Shawn Dolan Senior Scientist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (June 2012)

Attachment 1 Well Development Record



Well/Piezometer Development Record

Well ID:

Client: _____

Project No: _____ Date: _____ Developer: _____

Site Location: _____

Well/Piezometer Data

Well ☐ Piezometer ☐ Diameter _____ Material _____

Measuring Point Description _____ Geology at Screen Interval (if known) _____

Depth to Top of Screen (ft.) _____

Depth to Bottom of Screen (ft.) _____ Time of Water Level Measurement _____

Total Well Depth (ft.) _____ Calculate Purge Volume (gal.) _____

Depth to Static Water Level (ft.) _____ Disposal Method _____

Headspace _____

Original Well Development ☐ Redevelopment ☐ Date of Original Development _____

DEVELOPMENT METHOD

PURGE METHOD

Time	Total Volume Purged (gal.)	Flow Rate (gpm)	Turbidity (NTU)	Color	pH	Temp	Other

ACCEPTANCE CRITERIA (from workplan)

Minimum Purge Volume Required _____ gallons

Maximum Turbidity Allowed _____ NTUs

Stabilization of parameters _____ %

Has required volume been removed

Has required turbidity been reached

Has parameters stabilized

If no or N/A explain below:

Yes No N/A

☐ ☐ ☐

☐ ☐ ☐

☐ ☐ ☐

Signature _____

Date: _____

Monitoring Well Sampling

Procedure 3-14

1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the actions to be used during monitoring well sampling activities and establishes the method for sampling groundwater monitoring wells for water-borne contaminants and general groundwater chemistry. The objective is to obtain groundwater samples that are representative of aquifer conditions with as little alteration to water chemistry as possible.
- 1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).
- 1.3 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

- 2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to sampling the first well. All field sampling personnel responsible for sampling activities must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the well sampling tasks. Conduct preliminary area monitoring of sampling wells to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor phase and liquid matrix through the use of appropriate personal protective equipment (PPE).
- 2.2 Observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection during well sampling activities includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves and rubberized steel-toed boots. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on the contaminant concentrations. Refer to the project-specific HASP for the required PPE.
- 2.3 Physical Hazards associated with Well Sampling
 - To avoid lifting injuries associated with pump and bailers retrieval, use the large muscles of the legs, not the back.
 - Stay clear of all moving equipment, and avoid wearing loose fitting clothing.
 - When using tools for cutting purposes, cut away from yourself. The use of appropriate, task specific cutting tools is recommended.
 - To avoid slip/trip/fall conditions as a result of pump discharge, use textured boots/boot cover bottoms.
 - To avoid heat/cold stress as a result of exposure to extreme temperatures and PPE, drink electrolyte replacement fluids (1 to 2 cups per hour is recommended) and, in cases of extreme cold, wear fitted insulating clothing.
 - Be aware of restricted mobility due to PPE.

3.0 Terms and Definitions

None.

4.0 Interferences

4.1 Potential interferences could result from cross-contamination between samples or sample locations. Minimization of the cross-contamination will occur through the following:

- The use of clean sampling tools at each location as necessary.
- Avoidance of material that is not representative of the media to be sampled.

5.0 Training and Qualifications

5.1 Qualifications and Training

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 Responsibilities

5.2.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that monitoring well sampling activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all field sampling personnel involved in monitoring well sampling shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

5.2.3 The **Field Manager** is responsible for ensuring that all field sampling personnel follow these procedures.

5.2.4 **Field sampling personnel** are responsible for the implementation of this procedure.

5.2.5 The field sampler and/or task manager is responsible for directly supervising the groundwater sampling procedures to ensure that they are conducted according to this procedure and for recording all pertinent data collected during sampling.

6.0 Equipment and Supplies

6.1 Purging and Sampling Equipment

- Pump (Peristaltic, Portable Bladder, Submersible)
- Polyethylene or Teflon bladders (for portable bladder pumps)
- Bladder pump controller (for portable bladder pumps)
- Air compressor (for portable bladder pumps)
- Nitrogen cylinders (for portable bladder pumps)
- 12-volt power source
- Polyethylene inlet and discharge tubing (except for VOC analysis which requires Teflon tubing)
- Silicone tubing appropriate for peristaltic pump head
- Teflon bailer appropriately sized for well

- Disposable bailer string (polypropylene)
- Individual or multi-parameter water quality meter(s) with flow-through cell to measure temperature, pH, specific conductance, dissolved oxygen (DO), oxidation reduction potential (ORP), and/or turbidity
- Turbidity meter
- Water level meter
- Oil/water interface probe

6.2 General Equipment

- Sample kit (i.e., bottles, labels, preservatives, custody records and tape, cooler, ice)
- Sample Chain-of-Custody (COC) forms
- Sample Collection Records
- Sample packaging and shipping supplies
- Waterproof marker or paint
- Distilled/deionized water supply
- Water dispenser bottles
- Flow measurement cup or bucket
- 5-gallon buckets
- Instrument calibration solutions
- Stopwatch or watch
- Disposable Nitrile gloves
- Paper towels
- Trash bags
- Zipper-lock bags
- Equipment decontamination supplies
- Health and safety supplies (as required by the HASP)
- Approved plans such as: project-specific HASP and Sampling and Analysis Plan (SAP)
- Well keys or combinations
- Monitoring well location map(s)
- Field project logbook/pen

7.0 Calibration or Standardization

- 7.1 Field instruments will be calibrated daily according to the requirements of the SAP and manufacturer's specifications for each piece of equipment. Equipment will be checked daily with the calibration solutions at the end of use of the equipment. Calibration records shall be recorded in the field logbook or appropriate field form.
- 7.2 If readings are suspected to be inaccurate, the equipment shall be checked with the calibration solutions and/or re-calibrated.

8.0 Procedure

8.1 Preparation

8.1.1 Site Background Information

Establish a thorough understanding of the purposes of the sampling event prior to field activities. Conduct a review of all available data obtained from the site and pertinent to the water sampling. Review well history data including, but not limited to, well locations, sampling history, purging rates, turbidity problems, previously used purging methods, well installation methods, well completion records, well development methods, previous analytical results, presence of an immiscible phase, historical water levels, and general hydrogeologic conditions.

Previous groundwater development and sampling logs give a good indication of well purging rates and the types of problems that might be encountered during sampling, such as excessive turbidity and low well yield. They may also indicate where dedicated pumps are placed in the water column. To help minimize the potential for cross-contamination, well purging and sampling and water level measurement collection shall proceed from the least contaminated to the most contaminated well as indicated by previous analytical results. This order may be changed in the field if conditions warrant it, particularly if dedicated sampling equipment is used. A review of prior sampling procedures and results may also identify which purging and sampling techniques are appropriate for the parameters to be tested under a given set of field conditions.

8.1.2 Groundwater Analysis Selection

Establish the requisite field and laboratory analyses prior to water sampling. Decide on the types and numbers of quality assurance/quality control (QA/QC) samples to be collected (refer to the project-specific SAP), as well as the type and volume of sample preservatives, the type and number of sample containers, the number of coolers required, and the quantity of ice or other chilling materials. The field sampling personnel shall ensure that the appropriate number and size sample containers are brought to the site, including extras in case of breakage or unexpected field conditions. Refer to the project-specific SAP for the project analytical requirements.

8.2 Groundwater Sampling Procedures

Groundwater sampling procedures at a site shall include:

- 1) An evaluation of the well security and condition prior to sampling;
- 2) Decontamination of equipment;
- 3) Measurement of well depth to groundwater;
- 4) Assessment of the presence or absence of an immiscible phase;
- 5) Assessment of purge parameter stabilization;
- 6) Purging of static water within the well and well bore; and
- 7) Obtaining a groundwater sample.

Each step is discussed in sequence below. Depending upon specific field conditions, additional steps may be necessary. As a rule, at least 24 hours should separate well development and well sampling events. In all cases, consult the State and local regulations for the site, which may require more stringent time separation between well development and sampling.

8.2.1 Well Security and Condition

At each monitoring well location, observe the conditions of the well and surrounding area. The following information may be noted on a Groundwater Sample Collection Record (Attachment 1) or in the field logbook:

- Condition of the well's identification marker.
- Condition of the well lock and associated locking cap.
- Integrity of the well – well pad condition, protective outer casing, obstructions or kinks in the well casing, presence of water in the annular space, and the top of the interior casing.
- Condition of the general area surrounding the well.

8.2.2 Decontamination of Equipment

Where possible, dedicated supplies should be used at each well location to minimize the potential for cross-contamination and minimize the amount of investigation derived waste (IDW) fluids resulting from the decontamination process. If decontamination is necessary, establish a decontamination station before beginning sampling. The station shall consist of an area of at least 4 feet by 2 feet covered with plastic sheeting and be located upwind of the well being sampled. The station shall be large enough to fit the appropriate number of wash and rinse buckets, and have sufficient room to place equipment after decontamination. One central cleaning area may be used throughout the entire sampling event. The area around the well being sampled shall also be covered with plastic sheeting to prevent spillage. Further details are presented in SOP 3-06, Equipment Decontamination.

Decontaminate each piece of equipment prior to entering the well. Also, conduct decontamination prior to sampling at a site, even if the equipment has been decontaminated subsequent to its last usage. Additionally, decontaminate each piece of equipment used at the site prior to leaving the site. It is only necessary to decontaminate dedicated sampling equipment prior to installation within the well. Do not place clean sampling equipment directly on the ground or other contaminated surfaces prior to insertion into the well. Dedicated sampling equipment that has been certified by the manufacturer as being decontaminated can be placed in the well without on-site decontamination.

8.2.3 Measurement of Static Water Level Elevation

Before purging the well, measure water levels in all of the wells within the zone of influence of the well being purged. The best practice, if possible, is to measure all site wells (or wells within the monitoring well network) prior to sampling. If the well cap is not vented, remove the cap several minutes before measurement to allow water levels to equilibrate to atmospheric pressure.

Measure the depth to standing water and the total depth of the well to the nearest 0.01 foot to provide baseline hydrologic data, to calculate the volume of water in the well, and to provide information on the integrity of the well (e.g., identification of siltation problems). If not already present, mark an easily identified reference point for water level measurements which will become the measuring point for all water level measurements. This location and elevation must be surveyed.

The device used to measure the water level surface and depth of the well shall be sufficiently sensitive and accurate in order to obtain a measurement to the nearest 0.01 foot reliably. An electronic water level meter will usually be appropriate for this measurement; however, when the groundwater within a particular well is highly contaminated, an inexpensive weighted tape measure can be used to determine well depth to prevent adsorption of contaminants onto the meter tape. The presence of light, non-aqueous phase liquids (LNAPLs) and/or dense, non-aqueous phase liquids (DNAPLs) in a well requires measurement of the elevation of the top and the bottom of the product, generally using an interface probe. Water levels in such wells must then be corrected for density effects to accurately determine the elevation of the water table.

At each location, measure water levels several times in quick succession to ensure that the well has equilibrated to atmospheric conditions prior to recording the measurement. As stated above, measure all site wells (or wells within the monitoring well network) prior to sampling whenever possible. This will provide a water level database that describes water levels across the site at one time (a synoptic sampling). Prior to sampling, measure the water level in each well immediately prior to purging the well to ascertain that static conditions have been achieved prior to sampling.

8.2.4 Detection of Immiscible Phase Layers

Complete the following steps for detecting the presence of LNAPL and DNAPL before the well is purged for conventional sampling. These procedures may not be required for all wells. Consult the project-specific SAP to determine if assessing the presence of LNAPL and/or DNAPL is necessary.

- 1) Sample the headspace in the wellhead immediately after the well is opened for organic vapors using either a PID or an organic vapor analyzer, and record the measurements.
- 2) Lower an interface probe into the well to determine the existence of any immiscible layer(s), LNAPL and/or DNAPL, and record the measurements.
- 3) Confirm the presence or absence of an immiscible phase by slowly lowering a clear bailer to the appropriate depth, then visually observing the results after sample recovery.
- 4) In rare instances, such as when very viscous product is present, it may be necessary to utilize hydrocarbon- and water-sensitive pastes for measurement of LNAPL thickness. This is accomplished by smearing adjacent, thin layers of both hydrocarbon- and water-sensitive pastes along a steel measuring tape and inserting the tape into the well. An engineering tape showing tenths and hundredths of feet is required. Record depth to water, as shown by the mark on the water-sensitive paste, and depth to product, as shown by the mark on the product-sensitive paste. In wells where the approximate depth to water and product thickness are not known, it is best to apply both pastes to the tape over a fairly long interval (5 feet or more). Under these conditions, measurements are obtained by trial and error and may require several insertions and retrievals of the tape before the paste-covered interval of the tape encounters product and water. In wells where approximate depths of air-product and product-water interfaces are known, pastes may be applied over shorter intervals. Water depth measurements should not be used in preparation of water table contour maps until they are corrected for depression by the product.
- 5) If the well contains an immiscible phase, it may be desirable to sample this phase separately. Section 8.2.6 presents immiscible phase sampling procedures. It may not be meaningful to conduct water sample analysis of water obtained from a well containing LNAPLs or DNAPLs. Consult the **CTO Manager** and **Program Quality Manager** if this situation is encountered.

8.2.5 Purging Equipment and Use

General Requirements

The water present in a well prior to sampling may not be representative of in situ groundwater quality and shall be removed prior to sampling. Handle all groundwater removed from potentially contaminated wells in accordance with the IDW handling procedures in SOP 3-05, IDW Management. Purging shall be accomplished by methods as indicated in the project-specific SAP or by those required by State requirements. For the purposes of this SOP, purging methods will be described by removing groundwater from the well using low-flow techniques.

According to the U.S. Environmental Protection Agency (EPA) (EPA, 1996), the rate at which groundwater is removed from the well during purging ideally should be less than 0.2 to 0.3 liters/minute. EPA further states that wells should be purged at rates below those used to develop the well to prevent further development of the well, to prevent damage to the well, and to avoid disturbing accumulated

corrosion or reaction products in the well. EPA also indicates that wells should be purged at or below their recovery rate so that migration of water in the formation above the well screen does not occur.

Realistically, the purge rate should be low enough that substantial drawdown in the well does not occur during purging. In addition, a low purge rate will reduce the possibility of stripping volatile organic compounds (VOCs) from the water, and will reduce the likelihood of increasing the turbidity of the sample due to mobilizing colloids in the subsurface that are immobile under natural flow conditions.

The field sampler shall ensure that purging does not cause formation water to cascade down the sides of the well screen. Wells should not be purged to dryness if recharge causes the formation water to cascade down the sides of the screen, as this will cause an accelerated loss of volatiles. This problem should be anticipated based on the results of either the well development task or historical sampling events. In general, place the intake of the purge pump in the middle of the saturated screened interval within the well to allow purging and at the same time minimize disturbance/overdevelopment of the screened interval in the well. Water shall be purged from the well at a rate that does not cause recharge water to be excessively agitated unless an extremely slow recharging well is encountered where complete evacuation is unavoidable. During the well purging procedure, collect water level and/or product level measurements to assess the hydraulic effects of purging. Sample the well when it recovers sufficiently to provide enough water for the analytical parameters specified. If the well is purged dry, allow the well to recover sufficiently to provide enough water for the specified analytical parameters, and then sample it.

Evaluate water samples on a regular basis during well purging and analyze them in the field preferably using in-line devices (i.e., flow through cell) for temperature, pH, specific conductivity, dissolved oxygen (DO), and oxidation-reduction (redox) potential. Turbidity should be measured separately (outside of the flow-through cell) with a nephelometer or similar device.

Readings should be taken every 2 to 5 minutes during the purging process. These parameters are measured to demonstrate that the natural character of the formation waters has been restored.

Purging shall be considered complete per the requirements set forth in the project-specific SAP, State requirements, or when three consecutive field parameter measurements of temperature, pH, specific conductivity, DO and ORP stabilize within approximately 10 percent and the turbidity is at or below 10 nephelometric turbidity units (NTU) or within $\pm 10\%$ if above 10 NTU. This criterion may not be applicable to temperature if a submersible pump is used during purging due to the heating of the water by the pump motor. Enter all information obtained during the purging and sampling process into a groundwater sampling log. Attachment 1 shows an example of a groundwater sampling log and the information typically included in the form. Whatever form is used, all blanks need to be completed on the field log during field sampling.

Groundwater removed during purging shall be stored according to the project-specific SAP or per SOP 3-05, IDW Management.

Purging Equipment and Methods

Submersible Pump

A stainless steel submersible pump may be utilized for purging both shallow and deep wells prior to sampling the groundwater for semivolatile and non-volatile constituents, but are generally not preferred for VOCs unless there are no other options (e.g., well over 200 feet deep). For wells over 200 feet deep, the submersible pump is one of the few technologies available to feasibly accomplish purging under any yield conditions. For shallow wells with low yields, submersible pumps are generally inappropriate due to overpumpage of the wells (<1 gallon per minute), which causes increased aeration of the water within the well.

Steam clean or otherwise decontaminate the pump and discharge tubing prior to placing the pump in the well. The submersible pump shall be equipped with an anti-backflow check valve to limit the amount of

water that will flow back down the drop pipe into the well. Place the pump in the middle of the saturated screened interval within the well and maintain it in that position during purging.

Bladder Pump

A stainless steel bladder pump can be utilized for purging and sampling wells up to 200 feet in depth for volatile, semivolatile, and non-volatile constituents. Use of the bladder pump is most effective in low to moderate yield wells and are often the preferred method for low-flow sampling. When sampling for VOCs and/or SVOCs, Teflon bladders should be used. Polyethylene bladders may be used when sampling for inorganics.

Either compressed dry nitrogen or compressed dry air, depending upon availability, can operate the bladder pump. The driving gas utilized must be dry to avoid damage to the bladder pump control box. Decontaminate the bladder pump prior to use.

Centrifugal, Peristaltic, or Diaphragm Pump

A centrifugal, peristaltic, or diaphragm pump may be utilized to purge a well if the water level is within 20 feet of ground surface. New or dedicated tubing is inserted into the midpoint of the saturated screened interval of the well. Water should be purged at a rate that satisfies low-flow requirements (i.e., does not cause drawdown). Centrifugal, peristaltic, or diaphragm pump are generally discouraged for VOCs sampling; however, follow methods allowed per the project-specific SAP or State requirements.

Air Lift Pump

Airlift pumps are not appropriate for purging or sampling.

Bailer

Avoid using a bailer to purge a well because it can result in overdevelopment of the well and create excessive purge rates. If a bailer must be used, the bailer should either be dedicated or disposable. Teflon-coated cable mounted on a reel is recommended for lowering the bailer in and out of the well.

Lower the bailer below the water level of the well with as little disturbance of the water as possible to minimize aeration of the water in the well. One way to gauge the depth of water on the reel is to mark the depth to water on the bailer wire with a stainless steel clip. In this manner, less time is spent trying to identify the water level in the well.

8.2.6 Monitoring Well Sampling Methodologies

Sampling Light, Non-Aqueous Phase Liquids (LNAPL)

Collect LNAPL, if present, prior to any purging activities. The sampling device shall generally consist of a dedicated or disposable bailer equipped with a bottom-discharging device. Lower the bailer slowly until contact is made with the surface of the LNAPL, and to a depth less than that of the immiscible fluid/water interface depth as determined by measurement with the interface probe. Allow the bailer to fill with LNAPL and retrieve it.

When sampling LNAPLs, never drop bailers into a well and always remove them from the well in a manner that causes as little agitation of the sample as possible. For example, the bailer should not be removed in a jerky fashion or be allowed to continually bang against the well casing as it is raised. Teflon bailers should always be used when sampling LNAPL. The cable used to raise and lower the bailer shall be composed of an inert material (e.g., stainless steel) or coated with an inert material (e.g., Teflon).

Sampling Dense, Non-Aqueous Phase Liquids (DNAPL)

Collect DNAPL prior to any purging activities. The best method for collecting DNAPL is to use a double-check valve, stainless steel bailer, or a Kemmerer (discrete interval) sampler. The sample shall be collected by slow, controlled lowering of the bailer to the bottom of the well, activation of the closing device, and retrieval.

Groundwater Sampling Methodology

The well shall be sampled when groundwater within it is representative of aquifer conditions per the methods described in Section 8.2.5. Prior to sampling the flow-through cell shall be removed and the samples collected directly from the purge tubing. Flow rates shall not be adjusted once aquifer conditions are met. Additionally, a period of no more than 2 hours shall elapse between purging and sampling to prevent groundwater interaction with the casing and atmosphere. This may not be possible with a slowly recharging well. Measure and record the water level prior to sampling in order to monitor drawdown when using low-flow techniques and gauge well volumes removed and recharged when using non-low-flow techniques.

Sampling equipment (e.g., especially bailers) shall never be dropped into the well, as this could cause aeration of the water upon impact. Additionally, the sampling methodology utilized shall allow for the collection of a groundwater sample in as undisturbed a condition as possible, minimizing the potential for volatilization or aeration. This includes minimizing agitation and aeration during transfer to sample containers, minimizing exposure to sunlight, and immediately placing the sample on ice once collected.

Sampling equipment shall be constructed of inert material. Equipment with neoprene fittings, polyvinyl chloride (PVC) bailers, Tygon® tubing, silicon rubber bladders, neoprene impellers, polyethylene, and Viton® are not acceptable when sampling for organics. If bailers are used, an inert cable/chain (e.g., fluorocarbon resin-coated wire or stainless steel wire or cable) shall be used to raise and lower the bailer. Dedicated equipment is highly recommended for all sampling programs.

Submersible Pumps

The submersible pump must be specifically designed for groundwater sampling (i.e., pump composed of stainless steel and Teflon, sample discharge lines composed of Teflon) and must have a controller mechanism allowing the required low-flow rate. Adjust the pump rate so that flow is continuous and does not pulsate to avoid aeration and agitation within the sample discharge lines. Run the pump for several minutes at the low-flow rate used for sampling to ensure that the groundwater in the lines was obtained at the low-flow rate.

Bladder Pumps

A gas-operated stainless steel bladder pump with adjustable flow control and equipped with a Teflon bladder and Teflon-lined tubing can be effectively utilized to collect a groundwater sample and is considered to be the best overall device for sampling inorganic and organic constituents. If only inorganics are being sampled, polyvinyl bladders and tubing may be used. Operate positive gas displacement bladder pumps in a continuous manner so that they minimize discharge pulsation that can aerate samples in the return tube or upon discharge.

When using a compressor, take several precautions. If the compressor is being powered by a gasoline generator, position the generator downwind of the well. Ground fault circuit interrupters (GFCIs) should always be used when using electric powered equipment. Do not connect the compression hose from the compressor to the pump controller until after the engine has been started.

When all precautions are completed and the compressor has been started, connect the compression hose to the pump controller. Slowly adjust the control knobs to discharge water in the shortest amount of time while maintaining a near constant flow. This does not mean that the compressor must be set to discharge the water as hard as possible. The optimal setting is one that produces the largest volume of purge water per minute (not per purge cycle) while maintaining a near constant flow rate.

Prior to sampling, adjust the flow rate (purge rate) to yield 100 to 300 mL/minute. Avoid settings that produce pulsating streams of water instead of a steady stream if possible. Operate the pump at this low flow rate for several minutes to ensure that drawdown is not occurring. At no time shall the sample flow rate exceed the flow rate used while purging.

For those samples requiring filtration, it is recommended to use an in-line high capacity filter after all non-filtered samples have been collected.

Peristaltic Pumps:

A peristaltic pump is a type of positive displacement pump that moves water via the process of peristalsis. The pump uses a flexible hose fitted inside a circular pump casing. A rotor with cams compresses the flexible tube as the rotor turns, which forces the water to be pumped to move through the tube. In peristaltic pumps, no moving parts of the pump are in contact with the water being pumped. Displacement is determined by tube size, so delivery rate can only be changed during operation by varying pump speed. Peristaltic pumps are simple and quite inexpensive for the flow rates they provide.

There are several methods available for transferring the sample into the laboratory containers. The selected method may vary based on State requirements and should be documented in the project-specific SAP. Samples typically can be collected directly from the discharge end of the Teflon tubing, after it has been disconnected from the flow through cell. For volatile analyses, the sampler should make sure that the pump is set such that a smooth laminar flow is achieved. In all cases, the project team should consult their local regulatory requirements and document the selected sample collection procedure in the project-specific SAP.

Bailers

A single- or double-check valve Teflon or stainless steel bailer equipped with a bottom discharging device can be utilized to collect groundwater samples. Bailers have a number of disadvantages, however, including a tendency to alter the chemistry of groundwater samples due to degassing, volatilization, and aeration; the possibility of creating high groundwater entrance velocities; differences in operator techniques resulting in variable samples; and difficulty in determining where in the water column the sample was collected. Therefore, use bailers for groundwater sampling only when other types of sampling devices cannot be utilized for technical, regulatory, or logistical reasons.

Dedicated or disposable bailers should always be used in order to eliminate the need for decontamination and to limit the potential of cross-contamination. Each time the bailer is lowered to the water table, lower it in such a way as to minimize disturbance and aeration of the water column within the well.

8.2.7 Sample Handling and Preservation

Many of the chemical constituents and physiochemical parameters to be measured or evaluated during groundwater monitoring programs are chemically unstable and require preservation. The U.S. EPA document entitled, *Test Methods for Evaluating Solid Waste – Physical/Chemical Methods (SW-846)* (EPA 1997), includes a discussion of appropriate sample preservation procedures. In addition, SW-846 provides guidance on the types of sample containers to use for each constituent or common set of parameters. In general, check with specific laboratory or State requirements prior to obtaining field samples. In many cases, the laboratory will supply the necessary sample bottles and required preservatives. In some cases, the field sampling personnel may add preservatives in the field.

Improper sample handling may alter the analytical results of the sample. Therefore, transfer samples in the field from the sampling equipment directly into the container that has been prepared specifically for that analysis or set of compatible parameters as described in the project-specific SAP. It is not an acceptable practice for samples to be composited in a common container in the field and then split in the laboratory, or poured first into a wide mouth container and then transferred into smaller containers.

Collect groundwater samples and place them in their proper containers in the order of decreasing volatility and increasing stability. A preferred collection order for some common groundwater parameters is:

1. VOCs and total organic halogens (TOX)

2. Dissolved gases, total organic carbon (TOC), total fuel hydrocarbons
3. Semivolatile organics, pesticides
4. Total metals, general minerals (unfiltered)
5. Dissolved metals, general minerals (filtered)
6. Phenols
7. Cyanide
8. Sulfate and chloride
9. Nitrate and ammonia
10. Radionuclides

When sampling for VOCs, collect water samples in vials or containers specifically designed to prevent loss of VOCs from the sample. The analytical laboratory performing the analysis shall provide these vials. Collect groundwater from the sampling device in vials by allowing the groundwater to slowly flow along the sides of the vial. Sampling equipment shall not touch the interior of the vial. Fill the vial above the top of the vial to form a positive meniscus with no overflow. No headspace shall be present in the sample container once the container has been capped. This can be checked by inverting the bottle once the sample is collected and tapping the side of the vial to dislodge air bubbles. Sometimes it is not possible to collect a sample without air bubbles, particularly water that has high concentrations of dissolved gasses. In these cases, the field sampling personnel shall document the occurrence in the field logbook and/or sampling worksheet at the time the sample was collected. Likewise, the analytical laboratory shall note in the laboratory analysis reports any headspace in the sample container(s) at the time of receipt by the laboratory.

Special Handling Considerations

In general, samples for organic analyses should not be filtered. However, high turbidity samples for PCB analysis may require filtering. Consult the project-specific SAP for details on filtering requirements. Samples shall not be transferred from one container to another because this could cause aeration or a loss of organic material onto the walls of the container. TOX and TOC samples should be handled in the same manner as VOC samples.

When collecting total and dissolved metals samples, the samples should be collected sequentially. The total metals sample is collected from the pump unfiltered. The dissolved metals sample is collected after filtering with a 0.45-micron membrane in-line filter. Allow at least 500 mL of effluent to flow through the filter prior to sampling to ensure that the filter is thoroughly wetted and seated in the filter capsule. If required by the project-specific SAP, include a filter blank for each lot of filters used and always record the lot number of the filters.

Field Sampling Preservation

Preserve samples immediately upon collection. Ideally, sampling containers will be pre-preserved with a known concentration and volume of preservative. Certain matrices that have alkaline pH (greater than 7) may require more preservative than is typically required. An early assessment of preservation techniques, such as the use of pH strips after initial preservation, may therefore be appropriate. Guidance for the preservation of environmental samples can be found in the U.S. EPA *Handbook for Sampling and Sample Preservation of Water and Wastewater* (EPA 1982). Additional guidance can be found in other U.S. EPA documents (EPA 1992, 1996).

Field Sampling Log

A groundwater sampling log provided as Attachment 1 shall document the following:

- Identification of well

- Well depth
- Static water level depth and measurement technique
- Presence of immiscible layers and detection method
- Well yield
- Purge volume and pumping rate
- Time that the well was purged
- Sample identification numbers
- Well evacuation procedure/equipment
- Sample withdrawal procedure/equipment
- Date and time of collection
- Types of sample containers used
- Preservative(s) used
- Parameters requested for analysis
- Field analysis data
- Field observations on sampling event
- Name of sampler
- Weather conditions

9.0 Quality Control and Assurance

- 9.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the project-specific SAP. The goal of the QA program should be to ensure precision, accuracy, representativeness, completeness, and comparability in the project sampling program.
- 9.2 Quality control (QC) requirements for sample collection are dependent on project-specific sampling objectives. The project-specific SAP will provide requirements for sample preservation and holding times, container types, sample packaging and shipment, as well as requirements for the collection of various QC samples such as trip blanks, field blanks, equipment rinse blanks, and field duplicate samples.

10.0 Data and records management

- 10.1 Records will be maintained in accordance with SOP 3-03, Recordkeeping, Sample Labelling, and Chain-of-Custody. Various forms are required to ensure that adequate documentation is made of the sample collection activities. These forms may include:
- Sample Collection Records;
 - Field logbook;
 - Chain-of-custody forms; and
 - Shipping labels.

- 10.2 Sample collection records (Attachment 1) will provide descriptive information for the purging process and the samples collected at each monitoring well.
- 10.3 The field logbook is kept as a general log of activities and should not be used in place of the sample collection record.
- 10.4 Chain-of-custody forms are transmitted with the samples to the laboratory for sample tracking purposes.
- 10.5 Shipping labels are required is sample coolers are to be transported to a laboratory by a third party (courier service).

11.0 Attachments or References

Attachment 1 – Groundwater Sampling Collection Record

ASTM Standard D5088. 2008. *Standard Practice for Decontamination of Field Equipment Used at Waste Sites*. ASTM International, West Conshohocken, PA. 2008. DOI: 10.1520/D5088-02R08. www.astm.org.

Environmental Protection Agency, United States (EPA). 1982. *Handbook for Sampling and Sample Preservation of Water and Wastewater*. EPA-600/4-82-029. Cincinnati: EPA Office of Research and Development, Environmental Monitoring and Support Laboratory.

EPA. 1992. *RCRA Groundwater Monitoring Draft Technical Guidance*. EPA/530/R-93/001. Office of Solid Waste. November.

EPA. 1996. *Ground Water Issue: Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*. EPA/540/S-95/504. Office of Solid Waste and Emergency Response. April.

EPA. 1997. *Test Methods for Evaluating Solid Waste, Physical/Chemical Method (SW-846)*. 3rd ed., Final Update IIIA. Office of Solid Waste. Online updates at: <http://www.epa.gov/epaoswer/hazwaste/test/new-meth.htm>.

NAVSEA T0300-AZ-PRO-010. *Navy Environmental Compliance Sampling and Field Testing Procedures Manual*. August 2009.

SOP 3-03, *Recordkeeping, Sample Labelling, and Chain-of-Custody*.

SOP 3-05, *IDW Management*.

SOP 3-06, *Equipment Decontamination*.

<i>Author</i>	<i>Reviewer</i>	<i>Revisions (Technical or Editorial)</i>
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

Attachment 1

Groundwater Sample Collection Record



Well ID: _____

Groundwater Sample Collection Record

Client: _____	Date: _____	Time: Start _____ am/pm
Project No: _____		Finish _____ am/pm
Site Location: _____		
Weather Conds: _____	Collector(s): _____	

1. WATER LEVEL DATA: (measured from Top of Casing)

- a. Total Well Length _____ c. Length of Water Column _____ (a-b) Casing Diameter/Material _____
- b. Water Table Depth _____ d. Calculated Well Volume (see back) _____

2. WELL PURGEABLE DATA

- a. Purge Method: _____
- b. Acceptance Criteria defined (see SAP or Work Plan)
- Minimum Required Purge Volume (@ _____ well volumes) _____
 - Maximum Allowable Turbidity _____ NTUs
 - Stabilization of parameters _____ %
- c. Field Testing Equipment used:
- | Make | Model | Serial Number |
|------|-------|---------------|
| | | |
| | | |
| | | |

Time (min)	Volume Removed (gal)	Temp. (°C)	pH s.u.	Spec. Cond. (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (ml/min)	Drawdown (m)	Color/Odor/etc.

- d. Acceptance criteria pass/fail
- | | Yes | No | N/A |
|-------------------------------------|--------------------------|--------------------------|--------------------------|
| Has required volume been removed | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Has required turbidity been reached | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Have parameters stabilized | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
- If no or N/A - Explain below.
- _____

(continued on back)

3. SAMPLE COLLECTION:

Method: _____

Sample ID	Container Type	No. of Containers	Preservation	Analysis Req.	Time

Comments _____

Signature _____ Date _____

Soil and Rock Classification

Procedure 3-16

1.0 Purpose and Scope

- 1.1 The purpose of this document is to define the standard operating procedure (SOP) to thoroughly describe the physical characteristics of the sample and classify it according to the Unified Soil Classification System (USCS).
- 1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).
- 1.3 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review. If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to surface water sampling then those procedures may be added as an appendix to the project specific SAP.
- 1.4 It is fully expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be approved in advance by the Program Quality Manager. Deviations to this SOP will be documented in the field records.

2.0 Safety

- 2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to sampling. All **field sampling personnel** responsible for sampling activities must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the sampling tasks. Conduct preliminary area monitoring to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor and liquid phase through the use of respirators and disposable clothing.
- 2.2 In addition, observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection during well sampling activities includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves, rubberized steel-toed boots, and an American National Standards Institute-standard hard hat. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on the contaminant concentrations, and shall always be available on site.
- 2.3 Daily safety briefs will be conducted at the start of each working day before any work commences. These daily briefs will be facilitated by the **Site Safety Officer (SSO)** or designee to discuss the day's events and any potential health risk areas covering every aspect of the work to be completed. Weather conditions are often part of these discussions. As detailed in the HASP, everyone on the field team has the authority to stop work if an unsafe condition is perceived until the conditions are fully remedied to the satisfaction of the SSO.
- 2.4 The health and safety considerations for the work associated with soil classification include:

- At no time during classification activities are personnel to reach for debris near machinery that is in operation, place any samples in their mouth, or come in contact with the soils/rocks without the use of gloves.
- Stay clear of all moving equipment and be aware of pinch points on machinery. Avoid wearing loose fitting clothing.
- When using cutting tools, cut away from yourself. The use of appropriate, task specific cutting tools is recommended.
- To avoid heat/cold stress as a results of exposure to extreme temperatures and PPE, drink electrolyte replacement fluids (1 to 2 cups per hour is recommended) and in case of extreme cold, wear insulating clothing.

3.0 Terms and Definitions

None.

4.0 Interference

None.

5.0 Training and Qualifications

- 5.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that the soil and rock classification procedures comply with this procedure. The **CTO Manager** is responsible for ensuring that all personnel involved in soil and rock classification shall have the appropriate education, experience, and training to perform their assigned tasks.
- 5.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 5.3 The **Field Manager** is responsible for ensuring that all project **field personnel** follow these procedures.
- 5.4 Field personnel are responsible for the implementation of this procedure. Minimum qualifications for **field sampling personnel** require that one individual on the field team shall have a minimum of 6 months of experience with soil and rock classification.
- 5.5 The **project geologist** and/or **task manager** is responsible for directly supervising the soil and rock classification procedures to ensure that they are conducted according to this procedure, and for recording all pertinent data collected. If deviations from the procedure are required because of anomalous field conditions, they must first be approved by the **Program Quality Manager** and then documented in the field logbook and associated report or equivalent document.

6.0 Equipment and Supplies

- 6.1 The following equipment list contains materials which may be needed in carrying out the procedures outlined in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.
- Personal protective equipment (PPE) and other safety equipment, as required by the HASP
 - Field log book and pen with indelible ink
 - Boring log

- Munsell Soil Color Chart
- Scoopula, spatula, and/or other small hand tools
- California Sampler
- Hand-held penetrometer

7.0 Calibration or Standardization

None.

8.0 Procedure

8.1 Soil Classification

The basic purpose of the classification of soil is to thoroughly describe the physical characteristics of the sample and to classify it according to an appropriate soil classification system. The USCS was developed so that soils could be described on a common basis by different investigators and serve as a "shorthand" description of soil. A classification of a soil in accordance with the USCS includes not only a group symbol and name, but also a complete word description.

Describing soil on a common basis is essential so that soil described by different site qualified personnel is comparable. Site individuals describing soil as part of site activities *must* use the classification system described herein to provide the most useful geologic database for all present and future subsurface investigations and remedial activities.

The site geologist or other qualified individual shall describe the soil and record the description in a boring log, logbook, and/or electronic field data collection device. The essential items in any written soil description are as follows:

- Classification group name (e.g., silty sand)
- Color, moisture, and odor
- Range of particle sizes and maximum particle size
- Approximate percentage of boulders, cobbles, gravel, sand, and fines
- Plasticity characteristics of the fines
- In-place conditions, such as consistency, density, and structure
- USCS classification symbol

The USCS serves as "shorthand" for classifying soil into 15 basic groups:

GW ¹	Well graded (poorly sorted) gravel (>50 percent gravel, <5percent fines)
GP ¹	Poorly graded (well sorted) gravel (>50percent gravel, <5percent fines)
GM ¹	Silty gravel (>50 percent gravel, >15 percent silt)
GC ¹	Clayey gravel (>50 percent gravel, >15 percent clay)
SW ¹	Well graded (poorly sorted) sand (>50 percent sand, <5 percent fines)
SP ¹	Poorly graded (well sorted) sand (>50 percent sand, <5 percent fines)

¹ If percentage of fine is 5 percent to 15 percent, a dual identification shall be given (e.g., a soil with more than 50 percent poorly sorted gravel and 10 percent clay is designated GW-GC.

SM ¹	Silty sand (>50 percent sand, >15 percent silt)
SC ¹	Clayey sand (>50 percent sand, >15 percent clay)
ML ²	Inorganic, low plasticity silt (slow to rapid dilatancy, low toughness, and plasticity)
CL ²	Inorganic, low plasticity (lean) clay (no or slow dilatancy, medium toughness and plasticity)
MH ²	Inorganic elastic silt (no to slow dilatancy, low to medium toughness and plasticity)
CH ²	Inorganic, high plasticity (fat) clay (no dilatancy, high toughness, and plasticity)
OL	Organic low plasticity silt or organic silty clay
OH	Organic high plasticity clay or silt
PT	Peat and other highly organic soil

Figure 8-1 defines the terminology of the USCS. Flow charts presented in Figure 8-2 and indicate the process for describing soil. The particle size distribution and the plasticity of the fines are the two properties of soil used for classification. In some cases, it may be appropriate to use a borderline classification (e.g., SC/CL) if the soil has been identified as having properties that do not distinctly place the soil into one group.

8.1.1 Estimation of Particle Size Distribution

One of the most important factors in classifying a soil is the estimated percentage of soil constituents in each particle size range. Being proficient in estimating this factor requires extensive practice and frequent checking. The steps involved in determining particle size distribution are listed below:

1. Select a representative sample (approximately 1/2 of a 6-inch long by 2.5-inch diameter sample liner).
2. Remove all particles larger than 3 inches from the sample. Estimate and record the percent by volume of these particles. Only the fraction of the sample smaller than 3 inches is classified.
3. Estimate and record the percentage of dry mass of gravel (less than 3 inches and greater than 1/4 inch).
4. Considering the rest of the sample, estimate, and record the percentage of dry mass of sand particles (about the smallest particle visible to the unaided eye).
5. Estimate and record the percentage of dry mass of fines in the sample (do not attempt to separate silts from clays).
6. Estimate percentages to the nearest 5 percent. If one of the components is present in a quantity considered less than 5 percent, indicate its presence by the term "trace".
7. The percentages of gravel, sand, and fines must add up to 100 percent. "Trace" is not included in the 100 percent total.

8.1.2 Soil Dilatancy, Toughness, and Plasticity

8.1.2.1 Dilatancy

To evaluate dilatancy, follow these procedures:

² If the soil is estimated to have 15 percent to 25 percent sand or gravel, or both, the words "with sand" or "with gravel" (whichever predominates) shall be added to the group name (e.g., clay with sand, CL; or silt with gravel, ML). If the soil is estimated to have 30 percent or more sand or gravel, or both, the words "sandy" or "gravely" (whichever predominates) shall be added to the group name (e.g., sandy clay, CL). If the percentage of sand is equal to the percent gravel, use "sandy."

1. From the specimen, select enough material to mold into a ball about 1/2 inch (12 millimeters [mm]) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.
2. Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 8-1. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

Table 8-1: Criteria for Describing Dilatancy
















Description	Criteria
None	No visible change in specimen.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

8.1.2.2 Toughness

Following the completion of the dilatancy test, shape the test specimen into an elongated pat and roll it by hand on a smooth surface or between the palms into a thread about 1/8 inch (3 mm) in diameter. (If the sample is too wet to roll easily, spread it into a thin layer and allow it to lose some water by evaporation.) Fold the sample threads and re-roll repeatedly until the thread crumbles at a diameter of about 1/8 inch. The thread will crumble at a diameter of 1/8 inch when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, lump the pieces together and knead it until the lump crumbles. Note the toughness of the material during kneading. Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 8-2.

Table 8-2: Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread near the plastic limit. The thread and the lump have very high stiffness.

DEFINITION OF TERMS							
MAJOR DIVISIONS		SYMBOLS		TYPICAL DESCRIPTIONS			
COARSE GRAINED SOILS More Than Half of Material is Larger Than No. 200 Sieve Size	GRAVELS More Than Half of Coarse Fraction is Smaller Than No. 4 Sieve	CLEAN GRAVELS (Less than 6% Fines)		GW	Well graded gravels, gravel-sand mixtures, little or no fines		
		GRAVELS With Fines		GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		
				GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines		
				GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines		
	SANDS More Than Half of Coarse Fraction is Smaller Than No. 4 Sieve	CLEAN SANDS (Less than 6% Fines)		SW	Well graded sands, gravelly sands, little or no fines		
		SANDS With Fines		SP	Poorly graded sands, gravelly sands, little or no fines		
				SM	Silty sands, sand-silt mixtures, non-plastic fines		
				SC	Clayey sands, sand-clay mixtures, plastic fines		
FINE GRAINED SOILS More Than Half of Material is Smaller Than No. 200 Sieve Size	SILTS AND CLAYS Liquid Limit is Less Than 50%			ML	Inorganic silts, rock flour, fine sandy silts or clays, and clayey silts with non- or slightly-plastic fines		
				CL	Inorganic clays of low to medium plasticity, gravelly clays, silty clays, sandy clays, lean clays		
				OL	Organic silts and organic silty clays of low plasticity		
	SILTS AND CLAYS Liquid Limit is Greater Than 50%			MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts, clayey silt		
				CH	inorganic clays of high plasticity, fat clays		
				OH	Organic clays of medium to high plasticity, organic silts		
			HIGHLY ORGANIC SOILS				PT

GRAIN SIZES							
SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		
	200	40	10	4	3/4"	3"	12"
U.S. STANDARD SERIES SIEVE				CLEAR SQUARE SIEVE OPENINGS			

Figure8-1: Unclassified Soil Classification System (USCS)

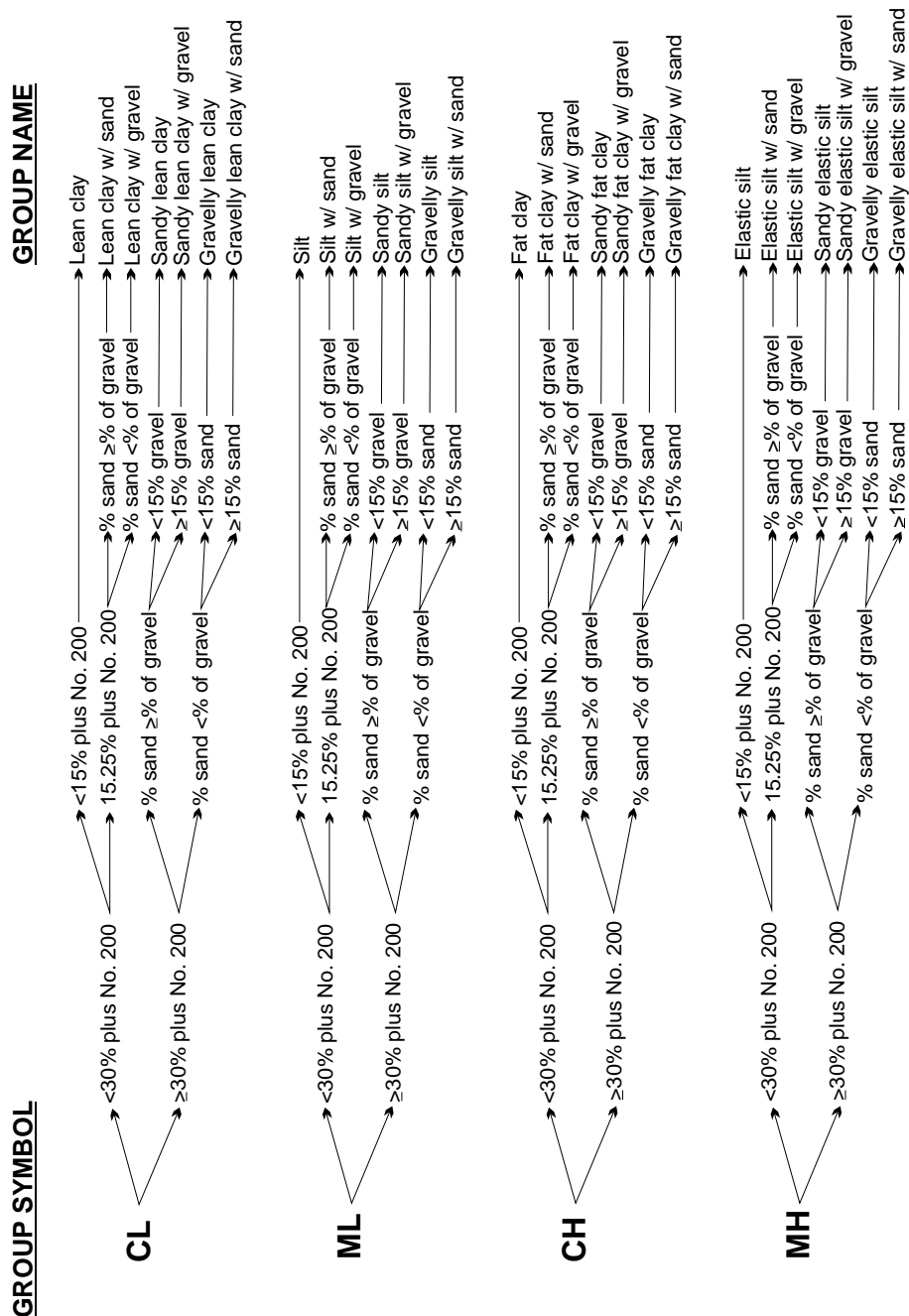


Figure 8-2: Flow Chart for Fine Grain Soil Classification

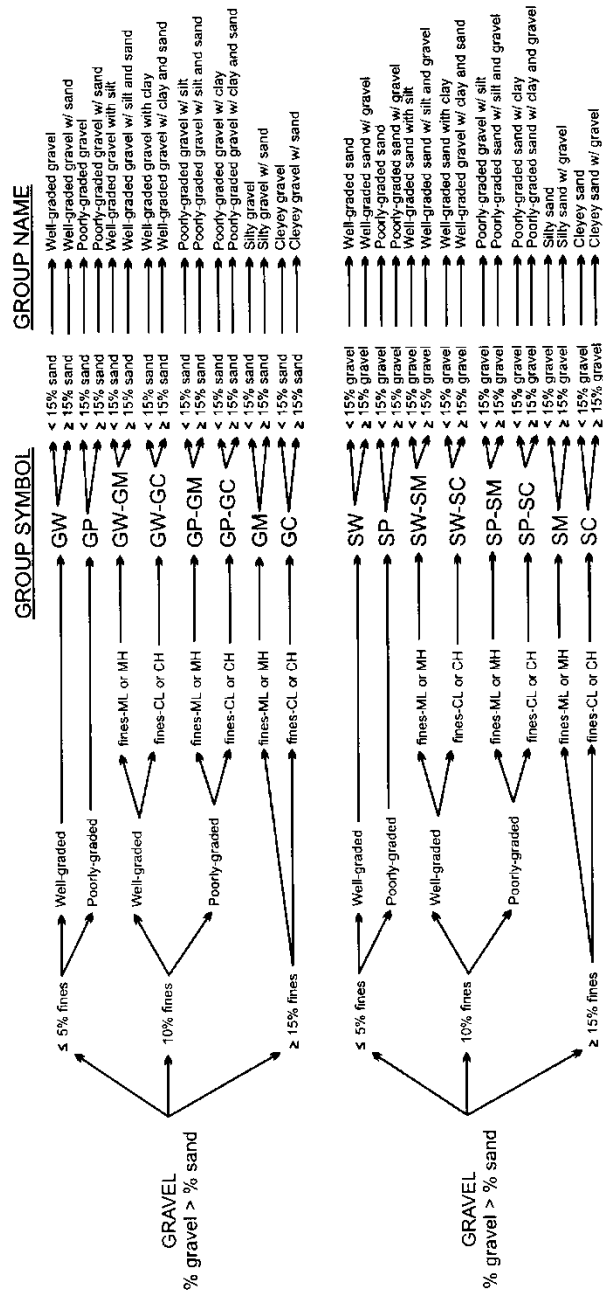


Figure 8-3: Flow Chart for Soil with Gravel

8.1.2.3 Plasticity

The plasticity of a soil is defined by the ability of the soil to deform without cracking, the range of moisture content over which the soil remains in a plastic state, and the degree of cohesiveness at the plastic limit. The plasticity characteristic of clays and other cohesive materials is defined by the liquid limit and plastic limit. The liquid limit is defined as the soil moisture content at which soil passes from the liquid to the plastic state as moisture is removed. The test for the liquid limit is a laboratory, not a field, analysis.

The plastic limit is the soil moisture content at which a soil passes from the plastic to the semi-solid state as moisture is removed. The plastic limit test can be performed in the field and is indicated by the ability to roll a 1/8-inch (0.125-inch) diameter thread of fines, the time required to roll the thread, and the number of times the thread can be re-rolled when approaching the plastic limit.

The plasticity tests are not based on natural soil moisture content, but on soil that has been thoroughly mixed with water. If a soil sample is too dry in the field, add water prior to performing classification. If a soil sample is too sticky, spread the sample thin and allow it to lose some soil moisture.

Table 8-3 presents the criteria for describing plasticity in the field using the rolled thread method.

Table 8-3: Criteria for Describing Plasticity

Description	Criteria
Non-Plastic	A 1/8-inch thread cannot be rolled.
Low Plasticity	The thread can barely be rolled.
Medium Plasticity	The thread is easy to roll and not much time is required to reach the plastic limit.
High Plasticity	It takes considerable time rolling the thread to reach the plastic limit.

8.1.3 Angularity

The following criteria describe the angularity of the coarse sand and gravel particles:

- **Rounded** particles have smoothly-curved sides and no edges.
- **Subrounded** particles have nearly plane sides, but have well-rounded corners and edges.
- **Subangular** particles are similar to angular, but have somewhat rounded or smooth edges.
- **Angular** particles have sharp edges and relatively plane sides with unpolished surfaces. Freshly broken or crushed rock would be described as angular.

8.1.4 Color, Moisture, and Odor

The natural moisture content of soil is very important. Table 8-4 shows the terms for describing the moisture condition and the criteria for each.

Table 8-4: Soil Moisture Content Qualifiers

Qualifier	Criteria
Dry	Absence of moisture, dry to the touch
Moist	Damp but no visible water
Wet	Visible water, usually soil is below water table

Color is described by hue and chroma using the Munsell Soil Color Chart (Munsell 2000). For uniformity, all site geologists shall utilize this chart for soil classification. Doing so will facilitate correlation of geologic units between boreholes logged by different geologists. The Munsell Color Chart is a small booklet of numbered color chips with names like "5YR 5/6, yellowish-red." Note mottling or banding of colors. It is particularly important to note and describe staining because it may indicate contamination.

In general, wear a respirator if strong organic odors are present. If odors are noted, describe them if they are unusual or suspected to result from contamination. An organic odor may have the distinctive smell of decaying vegetation. Unusual odors may be related to hydrocarbons, solvents, or other chemicals in the subsurface. An organic vapor analyzer may be used to detect the presence of volatile organic contaminants.

8.1.5 **In-Place Conditions**

Describe the conditions of undisturbed soil samples in terms of their density/consistency (i.e., compactness), cementation, and structure utilizing the following guidelines:

8.1.5.1 *Density/Consistency*

Density and consistency describe a physical property that reflects the relative resistance of a soil to penetration. The term “density” is commonly applied to coarse to medium-grained sediments (i.e., gravels, sands), whereas the term “consistency” is normally applied to fine-grained sediments (i.e., silts, clays). There are separate standards of measure for both density and consistency that are used to describe the properties of a soil.

The density or consistency of a soil is determined by observing the number of blows required to drive a 1 3/8-inch (35 mm) diameter split barrel sampler 18 inches using a drive hammer weighing 140 lbs (63.5 kilograms [kg]) dropped over a distance of 30 inches (0.76 meters). Record the number of blows required to penetrate each 6 inches of soil in the field boring log during sampling. The first 6 inches of penetration is considered to be a seating drive; therefore, the blow count associated with this seating drive is recorded, but not used in determining the soil density/consistency. The sum of the number of blows required for the second and third 6 inches of penetration is termed the “standard penetration resistance,” or the “N-value.” The observed number of blow counts must be corrected by an appropriate factor if a different type of sampling device (e.g., Modified California Sampler with liners) is used. For a 2 3/8-inch inner diameter (I.D.) Modified California Sampler equipped with brass or stainless steel liners and penetrating a cohesionless soil (sand/gravel), the N-value from the Modified California Sampler must be divided by 1.43 to provide data that can be compared to the 1 3/8-inch diameter sampler data.

For a cohesive soil (silt/clay), the N-value for the Modified California Sampler should be divided by a factor of 1.13 for comparison with 1 3/8-inch diameter sampler data.

Drive the sampler and record blow counts for each 6-inch increment of penetration until one of the following occurs:

- A total of 50 blows have been applied during any one of the three 6-inch increments; a 50-blow count occurrence shall be termed “refusal” and noted as such on the boring log.
- A total of 150 blows have been applied.
- The sampler is advanced the complete 18 inches without the limiting blow counts occurring, as described above.

If the sampler is driven less than 18 inches, record the number of blows per partial increment on the boring log. If refusal occurs during the first 6 inches of penetration, the number of blows will represent the N-value for this sampling interval. Table 8-5 and Table 8-6 present representative descriptions of soil density/consistency vs. N-values.

Table 8-5: Measuring Soil Density with a California Sampler – Relative Density (Sands, Gravels)

Description	Field Criteria (N-Value)	
	1 3/8 in. ID Sampler	2 in. ID Sampler using 1.43 factor
Very Loose	0–4	0–6
Loose	4–10	6–14
Medium Dense	10–30	14–43
Dense	30–50	43–71
Very Dense	> 50	> 71

Table 8-6: Measuring Soil Density with a California Sampler – Fine Grained Cohesive Soil

Description	Field Criteria (N-Value)	
	1 3/8 in. ID Sampler	2 in. ID Sampler using 1.13 factor
Very Soft	0–2	0–2
Soft	2–4	2–4
Medium Stiff	4–8	4–9
Stiff	8–16	9–18
Very Stiff	16–32	18–36
Hard	> 32	> 36

For undisturbed fine-grained soil samples, it is also possible to measure consistency with a hand-held penetrometer. The measurement is made by placing the tip of the penetrometer against the surface of the soil contained within the sampling liner or Shelby tube, pushing the penetrometer into the soil a distance specified by the penetrometer manufacturer, and recording the pressure resistance reading in pounds per square foot (psf). The values are as follows (Table 8-7):

Table 8-7: Measuring Soil Consistency with a Hand-Held Penetrometer

Description	Pocket Penetrometer Reading (psf)
Very Soft	0–250
Soft	250–500
Medium Stiff	500–1000
Stiff	1000–2000
Very Stiff	2000–4000
Hard	>4000

Consistency can also be estimated using thumb pressure using Table 8-8.

Table 8-8: Measuring Soil Consistency Using Thumb Pressure

Description	Criteria
Very Soft	Thumb will penetrate soil more than 1 inch (25 mm)
Soft	Thumb will penetrate soil about 1 inch (25 mm)
Firm	Thumb will penetrate soil about 1/4 inch (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very Hard	Thumbnail will not indent soil

8.1.5.2 *Cementation*

Cementation is used to describe the friability of a soil. Cements are chemical precipitates that provide important information as to conditions that prevailed at the time of deposition, or conversely, diagenetic effects that occurred following deposition. Seven types of chemical cements are recognized by Folk (1980). They are as follows:

- Quartz – siliceous
- Chert – chert-cemented or chalcedonic
- Opal – opaline
- Carbonate – calcitic, dolomitic, sideritic (if in doubt, calcareous should be used)
- Iron oxides – hematitic, limonitic (if in doubt, ferruginous should be used)
- Clay minerals – if the clay minerals are detrital or have formed by recrystallization of a previous clay matrix, they are not considered to be a cement. Only if they are chemical precipitates, filling previous pore space (usually in the form of accordion-like stacks or fringing radial crusts) should they be included as “kaolin-cemented,” “chlorite-cemented,” etc.
- Miscellaneous minerals – pyritic, collophane-cemented, glauconite-cemented, gypsiferous, anhydrite-cemented, baritic, feldspar-cemented, etc.

The degree of cementation of a soil is determined qualitatively by utilizing finger pressure on the soil in one of the sample liners to disrupt the gross soil fabric. The three cementation descriptors are as follows:

- Weak – friable; crumbles or breaks with handling or slight finger pressure
- Moderate – friable; crumbles or breaks with considerable finger pressure
- Strong – not friable; will not crumble or break with finger pressure

8.1.5.3 *Structure*

This variable is used to qualitatively describe physical characteristics of soil that are important to incorporate into hydrogeological and/or geotechnical descriptions of soil at a site. Appropriate soil structure descriptors are as follows:

- Granular – spherically shaped aggregates with faces that do not accommodate adjoining faces
- Stratified – alternating layers of varying material or color with layers at least 6 mm (1/4 inch) thick; note thickness
- Laminated – alternating layers of varying material or color with layers less than 6 mm (1/4 inch) thick; note thickness
- Blocky – cohesive soil that can be broken down into small angular or subangular lumps that resist further breakdown
- Lensed – inclusion of a small pocket of different soil, such as small lenses of sand, should be described as homogeneous if it is not stratified, laminated, fissured, or blocky. If lenses of different soil are present, the soil being described can be termed homogeneous if the description of the lenses is included
- Prismatic or Columnar – particles arranged about a vertical line, ped is bounded by planar, vertical faces that accommodate adjoining faces; prismatic has a flat top; columnar has a rounded top
- Platy – particles are arranged about a horizontal plane

8.1.5.4 *Other Features*

- Mottled – soil that appears to consist of material of two or more colors in blotchy distribution
- Fissured – breaks along definite planes of fracture with little resistance to fracturing (determined by applying moderate pressure to sample using thumb and index finger)
- Slickensided – fracture planes appear polished or glossy, sometimes striated (parallel grooves or scratches)

8.1.6 **Development of Soil Description**

Develop standard soil descriptions according to the following examples. There are three principal categories under which all soil can be classified. They are described below.

8.1.6.1 *Coarse-grained Soil*

Coarse-grained soil is divided into sands and gravels. A soil is classified as a sand if over 50 percent of the coarse fraction is “sand-sized.” It is classified as a gravel if over 50 percent of the coarse fraction is composed of “gravel-sized” particles.

The written description of a coarse-grained soil shall contain, in order of appearance: Typical name including the second highest percentage constituent as an adjective, if applicable (underlined); grain size of coarse fraction; Munsell color and color number; moisture content; relative density; sorting; angularity; other features, such as stratification (sedimentary structures) and cementation, possible formational name, primary USCS classification, secondary USCS classification (when necessary), and approximate percentages of minor constituents (i.e., sand, gravel, shell fragments, rip-up clasts) in parentheses.

Example: POORLY-SORTED SAND WITH SILT, medium- to coarse-grained, light olive gray, 5Y 6/2, saturated, loose, poorly sorted, subrounded clasts, SW/SM (minor silt with approximately 20 percent coarse-grained sand-sized shell fragments, and 80 percent medium-grained quartz sand, and 5 percent to 15 percent ML).

8.1.6.2 *Fine-grained Soil*

Fine-grained soil is further subdivided into clays and silts according to its plasticity. Clays are rather plastic, while silts have little or no plasticity.

The written description of a fine-grained soil should contain, in order of appearance: Typical name including the second highest percentage constituent as an adjective, if applicable (underlined); Munsell color; moisture content; consistency; plasticity; other features, such as stratification, possible formation name, primary USCS classification, secondary USCS classification (when necessary), and the percentage of minor constituents in parentheses.

Example: SANDY LEAN CLAY, dusky red, 2.5 YR 3/2, moist, firm, moderately plastic, thinly laminated, CL (70 percent fines, 30 percent sand, with minor amounts of disarticulated bivalves [about 5 percent]).

8.1.6.3 *Organic Soil*

For highly organic soil, describe the types of organic materials present as well as the type of soil constituents present using the methods described above. Identify the soil as an organic soil, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soil usually has a dark brown to black color and may have an organic odor. Often, organic soils will change color, (e.g., from black to brown) when exposed to air. Some organic soils will lighten in color significantly when air-dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

8.2 Example: ORGANIC CLAY, black, 2.5Y, 2.5/1, wet, soft, low plasticity, organic odor, OL (100 percent fines), weak reaction to HCl.

8.3 **Rock Classification**

The purpose of rock classification is to thoroughly describe the physical and mineralogical characteristics of a specimen and to classify it according to an established system. The generalized rock classification system described below was developed because, unlike the USCS for soils, there is no universally accepted rock classification system. In some instances, a more detailed and thorough rock classification system may be appropriate. Any modifications to this classification system, or the use of an alternate classification system should be considered during preparation of the site work plan. Both the CTO Manager and the QA Manager or Technical Director must approve any modifications to this classification system, or the use of another classification system.

Describing rock specimens on a common basis is essential so that rocks described by different site geologists are comparable. Site geologists describing rock specimens as a part of investigative activities must use the classification system described herein, or if necessary, another more detailed classification system. Use of a common classification system provides the most useful geologic database for all present and future subsurface investigations and remedial activities.

In order to provide a more consistent rock classification between geologists, a rock classification template has been designated as shown in **Error! Reference source not found.**. The template includes classification of rocks by origin and mineralogical composition. When classifying rocks, all site geologists shall use this template.

The site geologist shall describe the rock specimen and record the description in a boring log or logbook. The items essential for classification include (i.e., metamorphic foliated):

- Classification Name (i.e., schist)
- Color
- Mineralogical composition and percent
- Texture/Grain size (i.e., fine-grained, pegmatitic, aphyritic, glassy)
- Structure (i.e., foliated, fractured, lenticular)
- Rock Quality Designation (sum of all core pieces greater than two times the diameter of the core divided by the total length of the core run, expressed as a percentage)
- Classification symbol (i.e., MF)

Example: Metamorphic foliated schist: Olive gray, 5Y, 3/2, Garnet 25 percent, Quartz 45 percent, Chlorite 15 percent, Tourmaline 15 percent, Fine-grained with Pegmatite garnet, highly foliated, slightly wavy, MF.

9.0 Quality Control and Assurance

None


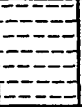

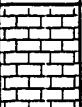


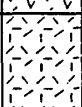

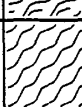
DEFINITION OF TERMS					
PRIMARY DIVISIONS			SYMBOLS		SECONDARY DIVISIONS
SEDIMENTARY ROCKS	Clastic Sediments	CONGLOMERATE		CG	Coarse-grained Clastic Sedimentary Rock types including: Conglomerates and Breccias
		SANDSTONE		SS	Clastic Sedimentary Rock types including: Sandstone, Arkose and Greywacke
		SHALE		SH	Fine-grained Clastic Sedimentary Rock types including: Shale, Siltstone, Mudstone and Claystone
	Chemical Precipitates	CARBONATES		LS	Chemical Precipitates including: Limestone, Crystalline Limestone, Fossiliferous Limestone Micrite and Dolomite
		EVAPORITES		EV	Evaporites including: Anhydrite, Gypsum, Halite, Travertine and Caliche
IGNEOUS ROCKS	EXTRUSIVE (Volcanic)			IE	Volcanic Rock types including: Basalt, Andesite, Rhyolite, Volcanic Tuff, and Volcanic Breccia
	INTRUSIVE (Plutonic)			II	Plutonic Rock types including: Granite, Diorite and Gabbro
METAMORPHIC ROCKS	FOLIATED			MF	Foliated Rock types including: Slate, Phyllite, Schist and Gneiss
	NON-FOLIATED			MN	Non-foliated Rock types including: Metaconglomerate, Quartzite and Marble

Figure 8-4: Rock Classification System

10.0 Data and Records Management

- 10.1 Document soil classification information collected during soil sampling onto the field boring logs, field trench logs, and into the field notebook. Copies of this information shall be sent to the **CTO Manager** for the project files.
- 10.2 Field notes will be kept during coring activities in accordance with SOP 3-03 – Recordkeeping, Sample Labeling, and Chain of Custody. The information pertinent to soil classification activities includes chronology of events, sample locations (x,y,z), time/date, sampler name, methods (including type of core liner/barrel, if applicable), sampler penetration and acceptability, sample observations, and the times and type of equipment decontamination. Deviations to the procedures detailed in the SOP should be recorded in the field logbook.

11.0 Attachments or References

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Author	Reviewer	Revisions (Technical or Editorial)
Robert Shoemaker Senior Scientist	Naomi Ouellette, Project Manager	Rev 0 – Initial Issue

Headspace Screening for Total VOCs

Procedure 3-19

1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the basic techniques for using headspace analysis to screen for volatile organics in contaminated soils using a portable Photo Ionization Detector (PID) or Flame Ionization Detector (FID).
- 1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

- 2.1 The health and safety considerations for the work associated with this SOP will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the Contract Task Order (CTO) Work Plan (WP) and/or direction from the **Site Safety Officer (SSO)**. Note that headspace screening usually requires Level D personal protection unless there is a potential for airborne exposure to site contaminants. Under circumstances where potential airborne exposure is possible respiratory protective equipment may be required based on personal air monitoring results. Upgrades to Level C will be coordinated with the Site Safety Officer (SSO) or **CTO Manager**.
- 2.2 Health and safety hazards and corresponding precautions include, but are not limited to, the following:
 - 2.2.1 Dermal contact with contaminated soil. Personnel should treat all soil as potentially contaminated and wear chemically impervious gloves. Minimize skin contact with soil by using sampling instruments such as stainless steel spades or spoons. Do not touch any exposed skin with contaminated gloves.
 - 2.2.2 Inhalation hazards. Appropriate air monitoring should be conducted to ensure that organic vapor concentrations in the breathing zone do not exceed action levels as specified in the Site-Specific HASP. When ambient temperatures are low enough to require warming samples using the vehicle heater, the vehicle's windows should be opened enough to prevent the build-up of any organic vapors. Use the PID or FID to verify the airborne concentrations in the vehicle remain below applicable action levels. Note that many volatile organic compounds (VOCs) are flammable and all precautions must be observed to eliminate any potential ignition sources.
 - 2.2.3 Shipping limitations. Follow applicable regulations when shipping FID/PID equipment. When shipping an FID by air, the hydrogen tank must be bled dry. Calibration gas canisters are considered dangerous goods and must be shipped according to IATA and DOT regulations. Consult your EHS Coordinator and check with your shipping company to determine the correct shipping procedures

3.0 Terms and Definitions

None.

4.0 Interferences

- 4.1 Regardless of which gas is used for calibration, the instrument will respond to all analytes present in the sample that can be detected by the type of lamp used in the PID.
- 4.2 Moisture will generate a positive interference in the concentration measured for a PID and is characterized by a slow increase in the reading as the measurement is made. Care must be taken to

minimize uptake of moisture to the extent possible. Refer to the manufacturers' instructions for care, cleaning, and maintenance.

- 4.3 Uptake of soil into the PID must be avoided as it will compromise instrument performance by blocking the probe, causing a positive interference, or dirtying the PID lamp. Refer to the manufacturers' instructions for care, cleaning, and maintenance.
- 4.4 The user should listen to the pitch of the sampling pump. Any changes in pitch may indicate a blockage and corrective action should be initiated.

5.0 Training and Qualifications

5.1 Qualifications and Training

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 Responsibilities

- 5.2.1 The CTO Manager is responsible for ensuring that the collection of headspace readings comply with this procedure. The CTO Manager is responsible for ensuring that all personnel involved in the collection of headspace readings shall have the appropriate education, experience, and training to perform their assigned tasks.
- 5.2.2 The Program Quality Manager is responsible for ensuring overall compliance with this procedure.
- 5.2.3 The Field Manager is responsible for ensuring that all headspace readings are conducted according to this procedure as well as verifying that the PID/FID is in proper operating condition prior to use and for implementing the calibration.
- 5.2.4 All Field Personnel are responsible for the implementation of this procedure.

6.0 Equipment and Supplies

- 6.1 The following materials must be on hand in good operating condition and/or in sufficient quantity to ensure that proper field analysis procedures may be followed:
- Calibrated PID/FID instrument;
 - Top-sealing "Zip-Loc" type plastic bags – or – 16 ounces of soil or "mason-" type glass jars and aluminum foil;
 - Project field book and/or boring logs;
 - Personal Protective Equipment (PPE) as specified in the project HASP; and
 - Material Safety Data Sheets (MSDSs) for any chemicals or site-specific contaminants.

7.0 Procedure

7.1 Preparation

Review available project information to determine the types of organic vapors that will likely be encountered to select the right instrument. The two basic types of instruments are FIDs and PIDs.

FIDs work well with organic compounds that have relatively lightweight molecules, but may have problems detecting halogenated compounds or heavier organic compounds; FIDs can detect methane for example. Since the FID uses a flame to measure organic compounds, ensure that work is conducted in an atmosphere, which is free of combustible vapors. If ambient temperatures are below 40°F, the flame of the FID may be difficult to light.

When using a PID, select an instrument that can measure the ionization potential of the anticipated contaminants of concern. PIDs work well with a range of organic compounds and can detect some halogenated hydrocarbons; PIDs cannot detect methane. The correct ultraviolet (UV) light bulb must be selected according to the types of organic vapors that will likely be encountered. The energy of the UV light must equal or exceed the ionization potential of the organic molecules that the PID will measure. The NIOSH Pocket Guide to Chemical Hazards is one source for determining ionization potentials for different chemicals. Bulbs available for PIDs include 9.4 eV, 10.6 (or 10.2) eV, and 11.7 eV bulbs. The 10.6 eV bulb is most commonly used as it detects a fairly large range of organic molecules and does not burn out as easily as the 11.7 eV bulb. The 9.4 eV bulb is the most rugged, but detects only a limited range of compounds. Under very humid or very cold ambient conditions, the window covering the UV light may fog up, causing inaccurate readings. Ask the **SSO** about correction factors when high humidity conditions exist.

After selecting the correct instrument, calibrate the PID/FID according to the manufacturer's instructions. Record background/ambient levels of organic vapors measured on the PID/FID after calibration and make sure to subtract the background concentration (if any) from your readings. Check the PID/FID readings against the calibration standard every 20 readings or at any time when readings are suspected to be inaccurate, and recalibrate, if necessary. Be aware that, after measuring highly contaminated soil samples, the PID/FID may give artificially high readings for a time.

7.2 **Top-Sealing Plastic Bag**

Place a quantity of soil in a top-sealing plastic bag and seal the bag immediately. The volume of soil to be used should be determined by the **CTO Manager** or **Field Manager**. The volume of soil may vary between projects but should be consistent for all samples collected for one project. Ideally, the bag should be at least 1/10th-filled with soil and no more than half-filled with soil. Once the bag is sealed, shake the bag to distribute the soil evenly. If the soil is hard or clumpy, use your fingers to gently work the soil (through the bag) to break up the clumps. Do not use a sampling instrument or a rock hammer since this may create small holes in the plastic bag and allow organic vapors to escape. Alternatively, the sample may be broken up before it is placed in the bag. Use a permanent marker to record the following information on the outside of the bag:

- Site identification information (i.e., borehole number);
- Depth interval; and
- Time the sample was collected. For example: "SS-12, 2-4 ft, @1425".

Headspace should be allowed to develop before organic vapors are measured with a PID/FID. The amount of time required for sufficient headspace development will be determined by the project-specific sampling plan and the ambient temperature. Equilibration time should be the same for all samples to allow an accurate comparison of organic vapor levels between samples. However, adjustments to equilibration times may be necessary when there are large variations in ambient temperature from day to day. When ambient temperatures are below 32°F, headspace development should be within a heated building or vehicle. When heating samples, be sure there is adequate ventilation to prevent the build-up or organic vapors above action levels.

Following headspace development, open a small opening in the seal of the plastic bag. Insert the probe of a PID/FID and seal the bag back up around the probe as tightly as possible. Alternatively, the probe can be inserted through the bag to avoid loss of volatiles. Since PIDs and FIDs are sensitive to moisture, avoid touching the probe to the soil or any condensation that has accumulated inside of the bag. Since the PID/FID consumes organic vapors, gently agitate the soil sample during the reading to release fresh organic vapors from the sample. Erratic meter response may occur at high organic vapor concentrations or conditions of elevated headspace moisture, in which case, headspace data should be discounted. Record the highest reading on the field form or in the field notebook as described in Section 9.

7.3 Jar and Aluminum Foil (Alternate Method)

Half-fill a clean glass jar with the soil sample to be screened. Quickly cover the jar's opening with one to two sheets of clean aluminum foil and apply the screw cap to tightly seal the jar. Allow headspace development for at least ten minutes. Vigorously shake the jar for 15 seconds, both at the beginning and at the end of the headspace development period. Where ambient temperatures are below 32°F (0°C), headspace development should be within a heated area. When heating samples, be sure there is adequate ventilation to prevent the build-up of organic vapors above action levels.

Subsequent to headspace development, remove the jar lid and expose the foil seal. Quickly puncture the foil seal with the instrument sampling probe, to a point about one-half of the headspace depth. Exercise care to avoid uptake of water droplets or soil particulates. As an alternative, use a syringe to withdraw a headspace sample, and then inject the sample into the instrument probe or septum-fitted inlet. This method is acceptable contingent upon verification of methodology accuracy using a test gas standard. Following probe insertion through the foil seal or sample injection to probe, record the highest meter response on the field form or in the field notebook. Using foil seal/probe insertion method, maximum response should occur between two and five seconds. Erratic meter response may occur at high organic vapor concentrations or conditions of elevated headspace moisture, in which case, headspace data should be discounted.

8.0 Quality Control and Assurance

Quality Assurance/Quality Control (QA/QC) will include the collection of duplicate samples. In general, one duplicate will be collected per 20 samples. Organic vapor concentrations measured in the primary and duplicate samples should be similar within plus or minus 20 percent. The frequency of headspace duplicate collection will be determined by the project manager/task manager. The PID/FID instrument must be calibrated according to the manufacturer's instructions before beginning screening, and checked or recalibrated every 20 analyses or when readings are suspected to be inaccurate. Record ambient organic vapor levels in the field notebook and on the field form. Periodically check ambient organic vapor levels. If ambient levels have changed more than 20 percent, recalibrate the PID/FID. Make sure readings are not collected near a vehicle exhaust or downwind of a drill rig exhaust. If grossly contaminated soil is encountered, decontaminate sampling instruments between samples and/or change contaminated gloves to avoid cross contaminating less contaminated samples.

9.0 Records, Data Analysis, Calculations

9.1 All data generated (results and duplicate comparisons) will be recorded in the field notebook and/or on the field form. Any deviation from the outlined procedure will also be noted. Field conditions (ambient temperature, wind, etc.) should also be recorded in the field notebook.

9.2 Readings may be recorded in a field notebook, on a boring log, or on an appropriate form specific to the project. The form should include the following information:

- When the PID/FID was calibrated (date/time) and calibration standard used;
- Background/ambient concentrations measured after PID/FID calibration;
- Location of sample (i.e., bore-hole number);
- Depth interval of sample measured;
- Lithology of material measured; and
- PID/FID reading and units of measure.

- 9.3 Note that if PID/FID measurements are recorded on a boring log, it is not necessary to duplicate information in the column where the PID/FID readings are recorded (e.g., borehole number, depth interval, lithology type).
- 9.4 All documentation will be stored in the project files and retained following completion of the project.

10.0 Attachments or References

SOP 3-20 Operation and Calibration of a Photoionization Detector

Author	Reviewer	Revisions (Technical or Editorial)
Robert Shoemaker Senior Scientist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

Operation and Calibration of a Photoionization Detector

Procedure 3-20

1.0 Purpose and Scope

1.1 Purpose and Applicability

- 1.1.1 This standard operating procedure (SOP) describes the procedures that will be followed by field staff for operation and calibration of a photoionization detector (PID). The PID is primarily used by AECOM personnel for safety and survey monitoring of ambient air, determining the presence of volatiles in soil and water, and detecting leakage of volatiles.
- 1.1.2 PIDs routinely used by field personnel include the Photovac Microtip, Thermoelectron 580EZ, and MiniRAE 2000. Personnel responsible for using the PID should first read and thoroughly familiarize themselves with the instrument instruction manual.

1.2 Principle of Operation

- 1.2.1 The PID is a non-specific vapor/gas detector. The unit generally consists of a hand-held probe that houses a PID, consisting of an ultraviolet (UV) lamp, two electrodes, and a small fan which pulls ambient air into the probe inlet tube. The probe is connected to a readout/control box that consists of electronic control circuits, a readout display, and the system battery. Units are available with UV lamps having an energy from 9.5 electron volts (eV) to 11.7 eV.
- 1.2.2 The PID analyzer measures the concentration of trace gas present in the atmosphere by photoionization. Photoionization occurs when an atom or molecule absorbs a photon of sufficient energy to release an electron and become a positive ion. This will occur when the ionization potential of the molecule (in electron volts (eV)) is less than the energy of the photon. The source of photons is an ultraviolet lamp in the probe unit. Lamps are available with energies ranging from 9.5 eV to 11.7 eV. All organic and inorganic vapor/gas compounds having ionization potentials lower than the energy output of the UV lamp are ionized and the resulting potentiometric change is seen as a positive reading on the unit. The reading is proportional to the concentration of organics and/or inorganics in the vapor.
- 1.2.3 Sample gases enter the probe through the inlet tube and enter the ion chamber where they are exposed to the photons emanating from the UV lamp. Ionization occurs for those molecules having ionization potentials near to or less than that of the lamp. A positive- biased polarizing electrode causes these positive ions to travel to a collector electrode in the chamber. Thus the ions create an electrical current which is amplified and displayed on the meter. This current is proportional to the concentration of trace gas present in the ion chamber and to the sensitivity of that gas to photoionization.
- 1.2.4 In service, the analyzer is first calibrated with a gas of known composition equal to, close to, or representative of that to be measured. Gases with ionization potentials near to or less than the energy of the lamp will be ionized. These gases will thus be detected and measured by the analyzer. Gases with ionization potentials greater than the energy of the lamp will not be detected. The ionization potentials of the major components of air, i.e., oxygen, nitrogen, and carbon dioxide, range from about 12.0 eV to 15.6 eV and are not ionized by any of the lamps available. Gases with ionization potentials near to or slightly higher than the lamp are partially ionized, with low sensitivity.

1.3 Specifications

- 1.3.1 Refer to the manufacturer's instructions for the technical specifications of the instrument being used. The operating concentration range is typically 0.1 to 2,000 ppm isobutylene equivalent.

2.0 Safety

- 2.1 The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the Contract Task Order (CTO) Work Plan (WP) and/or direction from the **Site Safety Officer (SSO)**.
- 2.2 Only PIDs stamped Division I Class I may be used in explosive atmospheres. Refer to the project HASP for instructions pertaining to instrument use in explosive atmospheres.

3.0 Terms and Definitions

None.

4.0 Interferences

- 4.1 Regardless of which gas is used for calibration, the instrument will respond to all analytes present in the sample that can be detected by the type of lamp used in the PID.
- 4.2 Moisture will generate a positive interference in the concentration measured for a PID and is characterized by a slow increase in the reading as the measurement is made. Care must be taken to minimize uptake of moisture to the extent possible. Refer to the manufacturers' instructions for care, cleaning, and maintenance.
- 4.3 Uptake of soil into the PID must be avoided as it will compromise instrument performance by blocking the probe, causing a positive interference, or dirtying the PID lamp. Refer to the manufacturers' instructions for care, cleaning, and maintenance.
- 4.4 The user should listen to the pitch of the sampling pump. Any changes in pitch may indicate a blockage and corrective action should be initiated.

5.0 Training and Qualifications

5.1 Qualifications and Training

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 Responsibilities

- 5.2.1 The CTO Manager is responsible for ensuring that the operation and calibration activities comply with this procedure. The CTO Manager is responsible for ensuring that all personnel involved in the operation and calibration shall have the appropriate education, experience, and training to perform their assigned tasks.
- 5.2.2 The Program Quality Manager is responsible for ensuring overall compliance with this procedure.
- 5.2.3 The Field Manager is responsible for ensuring that all operation and calibration activities are conducted according to this procedure.
- 5.2.4 All Field Personnel are responsible for the implementation of this procedure.

6.0 Equipment and Supplies

- Calibration Gas: Compressed gas cylinder of isobutylene in air or similar stable gas mixture of known concentration. The selected gas should have an ionization potential similar to that of the vapors to be monitored, if known. The concentration should be at 50-75% of the range in which the instrument is to be calibrated;

- Regulator for calibration gas cylinder;
- Approximately 6 inches of Teflon® tubing;
- Tedlar bag (optional);
- Commercially-supplied zero grade air (optional);
- "Magic Marker" or "Sharpie" or other waterproof marker;
- Battery charger;
- Moisture traps;
- Spare lamps;
- Manufacturer's instructions; and
- Field data sheets or logbook/pen.

7.0 Procedure

7.1 Preliminary Steps

- 7.1.1 Preliminary steps (battery charging, check-out, calibration, maintenance) should be conducted in a controlled or non-hazardous environment.

7.2 Calibration

- 7.2.1 The PID must be calibrated in order to display concentrations in units equivalent to ppm. First a supply of zero air (ambient air or from a supplied source), containing no ionizable gases or vapors is used to set the zero point. A span gas, containing a known concentration of a photoionizable gas or vapor, is then used to set the sensitivity.
- 7.2.2 Calibrate the instrument according to the manufacturer's instructions. Record the instrument model and identification number, the initial and adjusted meter readings, the calibration gas composition and concentration, and the date and the time in the field records.
- 7.2.3 If the calibration cannot be achieved or if the span setting resulting from calibration is 0.0, then the lamp must be cleaned (Section 7.4).

7.3 Operation

- 7.3.1 Turn on the unit and allow it to warm up (minimum of 5 minutes). Check to see if the intake fan is functioning; if so, the probe will vibrate slightly and a distinct sound will be audible when holding the probe casing next to the ear. Also, verify on the readout display that the UV lamp is lit.
- 7.3.2 Calibrate the instrument as described in Section 7.2, following the manufacturer's instructions. Record the calibration information in the field records.
- 7.3.3 The instrument is now operational. Readings should be recorded in the field records.
- 7.3.4 When the PID is not being used or between monitoring intervals, the unit may be switched off to conserve battery power and UV lamp life; however, a "bump" test should be performed each time the unit is turned on and prior to taking additional measurements. To perform a bump test, connect the outlet tubing from a Tedlar bag containing a small amount of span gas to the inlet tubing on the unit and record the reading. If the reading is not within the tolerance specified in the project plan, the unit must be recalibrated.
- 7.3.5 At the end of each day, recheck the calibration. The check will follow the same procedures as the initial calibration (Section 7.2) except that no adjustment will be made to the instrument. Record the information in the field records.

7.3.6 Recharge the battery after each use (Section 7.4).

7.3.7 When transporting, ensure that the instrument is packed in its stored condition in order to prevent damage.

7.4 **Routine Maintenance**

7.4.1 Routine maintenance associated with the use of the PID includes charging the battery, cleaning the lamp window, replacing the detector UV lamp, replacing the inlet filter, and replacing the sample pump. Refer to the manufacturer's instructions for procedures and frequency.

7.4.2 All routine maintenance should be performed in a non-hazardous environment.

7.5 **Troubleshooting Tips**

7.5.1 One convenient method for periodically confirming instrument response is to hold the sensor probe next to the tip of a magic marker. A significant reading should readily be observed.

7.5.2 Air currents or drafts in the vicinity of the probe tip may cause fluctuations in readings.

7.5.3 A fogged or dirty lamp, due to operation in a humid or dusty environment, may cause erratic or fluctuating readings. The PID should never be operated without the moisture trap in place.

7.5.4 Moving the instrument from a cool or air-conditioned area to a warmer area may cause moisture to condense on the UV lamp and produce unstable readings.

7.5.5 A zero reading on the meter should not necessarily be interpreted as an absence of air contaminants. The detection capabilities of the PID are limited to those compounds that will be ionized by the particular probe used.

7.5.6 Many volatile compounds have a low odor threshold. A lack of meter response in the presence of odors does not necessarily indicate instrument failure.

7.5.7 When high vapor concentrations enter the ionization chamber in the PID the unit can become saturated or "flooded". Remove the unit to a fresh air environment to allow the vapors to be completely ionized and purged from the unit.

8.0 **Quality Control and Assurance**

8.1 The end use of the data will determine the quality assurance requirements that are necessary to produce data of acceptable quality. These quality assurance requirements will be defined in the site-specific workplan or Sampling and Analysis Plan (SAP), hereafter referred to as the project plan.

8.2 Calibration of the PID will be conducted at the frequency specified in the project plan. In the absence of project-specific guidance, calibration will be performed at the beginning of each day of sampling and will be checked at the end of the sampling day or whenever instrument operation is suspect. The PID will sample a calibration gas of known concentration. The instrument must agree with the calibration gas within $\pm 10\%$. If the instrument responds outside this tolerance, it must be recalibrated.

8.3 Checks of the instrument response (Section 7.5) should be conducted periodically and documented in the field records.

9.0 **Records, Data Analysis, Calculations**

Safety and survey monitoring with the PID will be documented in a bound field logbook, or on standardized forms, and retained in the project files. The following information is to be recorded:

- Project name and number;
- Instrument manufacturer, model, and identification number;

- Operator's signature;
- Date and time of operation;
- Calibration gas used;
- Calibration check at beginning and end of day (meter readings before adjustment);
- Span setting after calibration adjustment;
- Meter readings (monitoring data obtained);
- Instances of erratic or questionable meter readings and corrective actions taken; and
- Instrument checks and response verifications – e.g., battery check, magic marker response (Section 7.5) or similar test.

10.0 Attachments or References

United States Environmental Protection Agency. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM). USEPA, Region 4, SESD, Enforcement and Investigations Branch, Athens, GA. November 2001.

Author	Reviewer	Revisions (Technical or Editorial)
Robert Shoemaker Senior Scientist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

Standard Operating Procedure SOP-3-24
Water Quality Parameter Testing for Groundwater Sampling

1.0 PURPOSE

This standard operating procedure (SOP) represents minimum standard of practice. State and federal requirements may vary, and this SOP does not replace state and federal requirements that must be consulted before work begins. Further, if a project-specific work plan has been created, the work plan should be considered the ruling document. This SOP may be modified to meet specific regulatory, client, or project specific criteria.

If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to water quality parameter testing, then those procedures may be added as an appendix to the project-specific Sampling and Analysis Plan (SAP).

2.0 SCOPE

This procedure provides guidance for expected sampling methods and protocols by all personnel related to the measurement of water quality parameters.

Field measurements of water quality parameters are commonly performed to evaluate surface water and groundwater. These tests are often performed to evaluate basic water quality parameters, to evaluate natural attenuation parameters, and to assess the presence of pore water entering a well.

As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved by either the Contract Task Order (CTO) Manager or the Quality Assurance (QA) Manager, and documented.

3.0 DEFINITIONS

3.1 Barometric Pressure (BP)

The density of the atmosphere, which varies according to altitude and weather conditions.

3.2 Conductivity/Specific Conductance

A measure of the ability of water to pass electrical current, which increases with the amount of dissolved ionic substances (i.e., salts). Conductivity is inversely related to the resistance of a solution and is measured in units of mhos per centimeter (mhos/cm) (inverse ohms/cm, Siemens/cm). The conductivity of water increases with increasing temperature.

Specific Conductance is corrected for 25 degrees Celsius (°C); for this reason, it is best to record Specific Conductance. If Conductivity is recorded, the temperature of the sample MUST recorded.

3.3 Dissolved Oxygen (DO)

The amount of oxygen present in water and available for respiration. DO is typically measured in milligrams per liter (mg/L). Oxygen is less soluble in warm and salty waters, so the instrument compensates the apparent percent saturation for changes in temperature and conductivity. Most probes measure the current resulting from the electrochemical reduction of oxygen (at a gold cathode) diffusing through a selective membrane. Because oxygen is being removed from the sample to perform the measurement, sample flow is required to prevent false low readings due to depletion of oxygen in the solution in front of the probe. Optical DO probes do not remove oxygen from the sample and are less affected by salts. The common range of DO in groundwater is 0.0 to 3.0 mg/L. Measurements outside of this range suggest that the meter may not be operating correctly.

3.4 Nephelometric Turbidity Unit (NTU)

The measurement of light passing through a sample based on the scattering of light caused by suspended particles.

3.5 pH

A measure of acidity and alkalinity of a solution using a logarithmic scale on which a value of 7 represents neutrality, lower numbers indicate increasing acidity, and higher numbers are increasingly basic.

3.6 Oxidation-Reduction Potential (ORP)

Also known as redox or eH, ORP is a measurement of the potential for a reaction to occur, which generally indicates the oxygen status of a sample. The probe consists of a platinum electrode, the potential of which is measured with respect to a reference electrode that rapidly equilibrates with the potential of the sample solution. A positive value indicates that oxygen is present. A negative value indicates an anaerobic environment or reducing condition. For this reason, negative ORP readings should be associated with DO readings of less than 0.5 mg/l; with negative ORP readings the water may exhibit a sulfur odor or gray color. Positive ORP readings should be associated with DO readings greater than 0.5 mg/L and lack of sulfur odors. Because of the complex relationship between ORP and temperature, no compensation is attempted; it is thus best to report both the ORP and temperature of a water sample.

3.7 Total Dissolved Solids

A measure of the quantity of materials in water that are either dissolved or too small to be filtered.

3.8 Turbidity

Measure of the clarity of water in NTUs. Potable water typically has NTU values between 0.0 and 0.3 NTUs, depending on the state or regulatory program.

4.0 RESPONSIBILITIES

The CTO Manager, or designee, is responsible for ensuring that these standard groundwater sampling activities are followed and shall review all groundwater sampling forms at the conclusion of a sampling event. The CTO Manager is responsible for ensuring that all personnel involved in monitoring well sampling shall have the appropriate education, experience, and training to perform their assigned tasks. The QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure. The Field Manager is responsible for ensuring that all project field staff follows these procedures.

Field sampling personnel are responsible for the implementation of this procedure. Personnel are required to be knowledgeable of the procedures in this SOP. Training and familiarization with this SOP shall be documented in the training file for each employee. The field sampler and/or Field Manager is responsible for directly supervising the calibration procedures to ensure that they are conducted according to this procedure, and for recording all pertinent data. If deviations from the procedure are required because of anomalous field conditions, they must first be approved by the CTO Manager, QA Manager, or Technical Director and then documented in the field logbook and associated report or equivalent document.

5.0 PROCEDURES

5.1 Purpose

The procedures will vary depending on parameters being measured, method of sampling, and the method of measurement used. The information here is a general guidance and the site-specific documents and manufacturer manuals supersede these procedures.

5.2 Cautions

Improper use of water quality testing equipment could result in equipment damage or compromised sampling results. Personnel should be trained to operate the test equipment being used for a field operation and should be trained in the proper techniques for collecting and

logging water quality parameters. Personnel should also be able to recognize problems with test equipment and have someone available for basic troubleshooting and repair.

5.3 Interferences

During field testing, water quality data that is documented from field testing equipment may be influenced by certain outside factors that are unrelated to the actual site water quality. Such parameters and equipment include the following:

pH Meters

- Coatings of oils, greases, and particles may impair the electrode's response. Pat the electrode bulb dry with lint-free paper or cloth and rinse with de-ionized water. For cleaning hard-to-remove films, use isopropyl alcohol very sparingly so that the electronic surface is not damaged.
- Poorly buffered solutions with low specific conductance (less than 200 microsiemens per centimeter) may cause fluctuations in the pH readings. Equilibrate electrode by immersing in several aliquots of sample before taking pH.

Dissolved Oxygen

- Dissolved gases (e.g., hydrogen sulfide, halogens, sulfur dioxide) are a factor with the performance of DO probes. The effect is less pronounced on optical DO meters. Meter type and potential interferences should be considered based on potential sulfate/sulfide or nitrate/nitrite reducing environments.
- Exposure of the sample to the atmosphere will cause elevated DO measurements.

Turbidity Meter

- If the weather is warm and humidity is high, condensation may collect on the cuvet. To avoid this, allow the sample to warm and dry the outside of the cuvet before making the measurement. One method used to accomplish this is to place the cuvet against one's body (armpits work well).

Temperature

- Sample temperature will change rapidly when there are significant differences between the sample and ambient air.

5.4 Apparatus and Materials

Field personnel shall consult the site work plan and SAP to review the equipment requirements for the sampling procedures to be followed during the sampling effort. The specific apparatus and materials required will depend on the water quality parameters being monitored. Table 1 shows the common equipment used in water quality parameter testing.

Table 1
Water Quality Parameter Testing — Common Equipment

Water Quality Parameter Instrument	Calibration Standards Required	Other Equipment
pH Meter	Yes - 2 or 3 Point Standards depending on groundwater range. Calibration must cover the range to be measured. If samples are above or below typical buffer standards (4, 7 and 10), special order buffers that fall outside groundwater pH range.	Container or flow thru cell for holding sample
Specific Conductance	Yes	Container or flow thru cell for holding sample
ORP Meter	Yes	Container or flow thru cell for holding sample
Turbidity Meter	Yes	Container or flow thru cell for holding sample
DO	No	Container or flow thru cell for holding sample
Thermometer	No	Container or flow thru cell for holding sample
Flow Rate	No	Calibrated Container

Notes:

ORP = Oxidation-Reduction Potential
 DO = Dissolved Oxygen

5.5 Instrument or Method Calibration

Most monitoring instruments require calibration before use, and this calibration must be conducted in the field under the ambient climatic conditions that will be present during field sampling. Calibration of monitoring instruments shall be performed in accordance with the manufacturer's specifications and recorded in the provided form in Attachment 1. Site-specific instrument calibration requirements should be specified in the SAP. The following minimum calibration requirements apply to the various types of meters used to gather water quality measurements.

Initial Calibration (IC): Before use, the instrument or meter electronics are adjusted (manually or automatically) to a theoretical value (e.g., DO saturation) or a known value of a

calibration standard. An IC is performed in preparation for the first use of an instrument or if a calibration verification does not meet acceptance criteria.

Initial Calibration Verification (ICV): The instrument or meter calibration is checked or verified directly following IC by measuring a calibration standard of known value as if it were a sample and comparing the measured result to the calibration acceptance criteria for the instrument/parameter. If an ICV fails to meet acceptance criteria, immediately recalibrate the instrument using the applicable initial calibration procedure or remove it from service.

Continuing Calibration Verification (CCV): After use, the instrument or meter calibration is checked or verified by measuring a calibration standard of known value as if it were a sample and comparing the measured result to the calibration acceptance criteria for the instrument/parameter.

5.5.1 Calibration Checks

Calibration checks are conducted by measuring a known standard. They must be completed after calibration and should be performed at least one other time (i.e., after lunch) and anytime suspect measurements are encountered. Table 2 provides general acceptance ranges to be used during calibration checks. If a meter is found to be outside of the acceptance range, the meter **must** be recalibrated. If the meter remains out of range, the project manager and/or the supplier of the meter should be contacted to determine alternative measures.

Table 2
Calibration Check Acceptance Limits

Parameter	Acceptance Criteria
Dissolved Oxygen	±0.3 mg/L of the theoretical oxygen solubility
Oxidation-Reduction Potential	±10 mv from the theoretical standard value at that temperature
pH	±0.2 Standard pH Units
Specific Conductance	±5% of the standard
Turbidity	0.1 to 10 NTU: ±10% of the standard 11 to 40 NTU: ±8% of the standard 41 to 100 NTU: ±6.5% of the standard

Notes:

mg/L = milligrams per liter
 mv = millivolts
 NTU = nephelometric turbidity units

5.5.2 Possible and Suspected Ranges

The concentration for each parameter range should be known so that concentrations outside of the range can be noted. Table 3 presents the maximum range of the parameter in groundwater. The table also presents the suspected range. Measurements outside of the maximum/minimum range should be considered in error and the measurement method should be checked. Concentrations outside the normal range should be treated as suspect but may be the result of contaminant impact. For example, a pH of 2.0 would be out of the normally suspected range for groundwater but not at a site impacted with an acid.

Table 3
Minimum and Maximum Result Ranges

Parameter	Units	Possible Min	Possible Max	Normal Min	Normal Max	Notes
						The colder the sample, the higher the DO reading.
Dissolved Oxygen	mg/L	0.0	14.6 (0°C) 10.1 (15°C) 8.3 (2°C)	0.0	5	DO greater than 1 mg/L, ORP positive should not have sulfur odor, sulfide, ferrous iron and/or gray color. DO less than 1 mg/L, ORP negative, may have sulfur odor, sulfide, ferrous iron and/or gray color.
pH	SU	0	14	5	9	pH values exceeding 10 could indicate grout contamination
ORP	mv					DO greater than 1 mg/L, ORP positive should not have sulfur odor, sulfide, ferrous iron and/or gray color. DO less than 1 mg/L, ORP negative, may have sulfur odor, sulfide, ferrous iron and/or gray color.
Specific Conductance	µS/cm			varies	varies	
Temperature	°C	0	100	5	30	
Turbidity	NTU	0	Greater than 1,000	0	Greater than 1,000	50 NTU or greater suggests cloudiness.

Notes:

mg/L = milligrams per liter
 °C = degrees Celsius
 DO = dissolved oxygen
 SU = standard units
 ORP = oxidation reduction potential
 mv = millivolts
 mS/cm = micro Siemens per cm
 NTU = nephelometric turbidity units

5.5.3 Field Instruments and Calibration Criteria

The calibration acceptance criteria for each instrument are summarized in Table 4 along with special considerations related to each field instrument.

Table 4
Calibration Check Acceptance Limits

Parameter	Acceptance Criteria
Dissolved Oxygen	±0.3 mg/L of the theoretical oxygen solubility.
Oxidation-Reduction Potential	±10 mv from the theoretical standard value at that temperature.
pH	±0.2 Standard pH Units
Specific Conductance	±5% of the standard
Turbidity	0.1 to 10 NTU: ±10% of the standard
	11 to 40 NTU: ±8% of the standard
	41 to 100 NTU: ±6.5% of the standard

Notes:

mg/L = milligrams per liter
 mv = millivolts
 NTU = nephelometric turbidity units

pH Meters

- For the most accurate of pH measurements, pH meters should receive a three-point calibration. However, if a two-point calibration will bracket the groundwater pH of the site, a two-point calibration is acceptable. Three-point calibrations typically include calibrating to solutions of pH 7.00, 4.00, and 10.00. If groundwater pH is outside the calibration range of the solution standards, special buffers must be ordered to bracket the pH. Some meters will report the slope of the calibration and this may be used in checking the meter calibration (refer to the meter's manual). When performing an ICV, the result must be within +/- 0.2 pH units of the stated buffer value.
- pH meters should be calibrated across the range of values to be measured. The maximum and minimum calibration solutions shall be outside the range of anticipated values. For example, if the expected range is between 7.50 and 9.00, the 7.00 and the 10.00 standard should be used for calibration. Perform the IC using at least two buffers, and always use the pH 7.00 buffer first. A reading that is above the maximum (or below the minimum) calibration standard is an estimate only and is not valid. This condition requires obtaining a new standard that is above (or below) the reported value, depending on the measurement.

- A percent slope of less than 90 percent indicates a bad electrode that must be changed or repaired. If percent slope cannot be determined, or the manufacturer's optimum specifications are different, follow the manufacturer's recommendation for maintaining optimum meter performance.

Specific Conductivity Meters

- For IC, when the sample measurements are expected to be 100 microsiemens per centimeter ($\mu\text{S}/\text{cm}$) or greater, use two standard potassium chloride (KCl) solutions that bracket the range of expected sample conductivities. Calibrate the instrument with the first standard. Verify the calibration of the instrument with the second standard, bracketing the range of expected sample values.
- If the instrument can be calibrated with more than one standard, choose additional calibration standards within the range of expected sample values.
- When the sample measurements are expected to be less than 100 $\mu\text{S}/\text{cm}$, a lower bracket is not required, but one standard (KCl) solution that is within the range of expected measurements must be used for the IC and the ICV.
- Accept the calibration if the meter reads within +/- 5 percent of the value of any calibration standard used to verify the calibration.
- Most field instruments read conductivity directly. Record all readings and calculations in the calibration records.
- For CCV, check the meter with at least one KCl standard with a specific conductance in the range of conductivity measured in environmental samples. The reading for the calibration verification must also be within +/- 5 percent of the standard value.
- If new environmental samples are encountered outside the range of the IC, verify the instrument calibration with two standards bracketing the range of sample values. If these calibration verifications fail, recalibrate the instrument.

Dissolved Oxygen Meters

- Before calibrating, check the probe membrane for bubbles, tears, or wrinkles. These conditions require replacement of the membrane in accordance with the manufacturer's directions.
- If the meter provides readings that are off-scale, will not calibrate, or drift, check the leads, contacts, etc., for corrosion and/or short circuits. These conditions require replacement maintenance in accordance with the manufacturer's directions.
- Most DO meters must be calibrated based on an environment of 100 percent humidity and a known elevation and barometric pressure (BP).
- For 100 percent humidity, place the probe in the calibration container with a moist towel and allow the probe to remain, undisturbed, for 10 to 20 minutes.
- The IC is an air calibration at 100% saturation. Before use, verify the meter calibration in water-saturated air to make sure it is properly calibrated and operating correctly. Make a similar verification at the end of the day or sampling event. Follow the manufacturer's instructions for your specific instrument. Allow an appropriate warm up period before IC. Wet the inside of the calibration chamber with water, pour out the excess water (leave a few drops), wipe any droplets off the membrane/sensor and insert the sensor into the chamber (this ensures 100 percent humidity). Allow adequate time for the DO sensor and the air inside the calibration chamber to equilibrate. Once the probe/calibration chamber is stable at ambient temperature, check the air temperature and determine, from the DO versus temperature table (see Attachment 2) what DO should measure. The acceptance criterion for DO ICV is +/- 0.3 mg/L.
- Use the same procedure as above for CCV.

ORP Meters

- Verify electrode response before use in the field.
- Equilibrate the standard solution to the temperature of the sample. The standard solution is based on a 25°C temperature; however, the calibration solution standard's value will require adjustment based on the temperature.

- Immerse the electrodes and gently stir the standard solution in a beaker (or flow cell). Turn the meter on, placing the function switch in the millivolt (mv) mode.
- Let the electrode equilibrate and record the reading to the nearest millivolt. The reading must be within ± 10 mv from the theoretical redox standard value at that temperature. If not, determine the problem and correct it before proceeding. Switch to temperature display and read the value.
- Record the mv reading and temperature in the field notebook or in form. Rinse the electrode with distilled water and proceed with the sample measurement, unless using a flow cell. If a flow cell is used, rinse between sample locations.

Turbidity Meters

- Perform an initial calibration using at least two primary standards.
- If the instrument cannot be calibrated with two standards, calibrate the instrument with one standard and verify with a second standard.
- Perform an ICV by reading at least one primary standard as a sample. The acceptance criterion for the ICV depends on the range of turbidity of the standard value:
 1. Standard Value = 0.1 to 10 NTU: the response must be within 10 percent of the standard;
 2. Standard Value = 11 to 40 NTU: the response must be within 8 percent of the standard;
 3. Standard Value = 41 to 100 NTU: the response must be within 6.5 percent of the standard; and
 4. Standard Value greater than 100 NTU: the response must be within 5 percent of the standard.
- Determining the Values of Secondary Standards: Use only those certified by the manufacturer for a specific instrument. Secondary standards may be used for CCVs.

To initially determine the value of a secondary standard, assign the value that is determined immediately after an ICV or verification with primary standards. This is done by reading the secondary standard as a sample. This result must be within the manufacturer's stated tolerance range and ± 10 percent of the assigned standard value. If the ± 10 percent criterion is not met, assign this reading as the value of the standard. If the reading is outside the manufacturer's stated tolerance range, discard the secondary standard.

- CCV: Perform a CCV using at least one primary or secondary standard. The calibration acceptance criteria are the same as those for an ICV.

5.6 Direct Measurements

Direct measurements with meters are the most common methods and can be accomplished by placing a sample in a container with the probe or by allowing the water to flow past the probe in a flow cell. The use of a flow-through cell improves measurement quality by allowing the constant flow of water over the probes and reduces interaction of the sample with the atmosphere. Sample cups should be avoided. The quantity of samples, timing, and methodology should be described in the project SAP.

Following calibration of required probes, connect the bottom flow-cell port to the discharge line of the pump. Connect the top port to a discharge line directed to a bucket to collect the purge water. Allow the flow cell to completely fill. As the water flows over the probe, record the measurements. Continue to record the measurements at regular intervals, as specified in the SAP.

When the ambient air temperatures are much higher or lower than the temperature of the water sample, it is best to keep the length of tubing between the wellhead and the flow cell as short as possible to prevent heating or cooling of the water. Tubing and flow-through cell should not be exposed to direct sunlight, particularly in the summer, if at all possible, to avoid heating of water samples.

5.7 Data Acquisitions, Calculations, and Data Reduction

5.7.1 Specific Conductivity Correction Factors

If the meter does not automatically correct for temperature (i.e., read Specific Conductivity) record Conductivity and adjust for temperature upon returning to the office. The following equation can be used to convert Conductivity to Specific Conductivity.

$$K = \frac{(Km)(C)}{1 + 0.0191(T - 25)}$$

Where:

- K = Conductivity in $\mu\text{mhos/cm}$ at 25°C
 Km = Measured conductivity in $\mu\text{mhos/cm}$ at T degrees Celsius
 C = Cell constant
 T = Measured temperature of the sample in degrees Celsius;

If the cell constant is 1, the formula for determining conductivity becomes:

$$K = \frac{(Km)}{1 + 0.0191(T - 25)}$$

5.7.2 Percentage Difference Calculation

For evaluating slope of readings from either a flow cell or a sample cup.

$$\%Difference = \frac{(Highest\ Value - Lowest\ Value)}{(Highest\ Value)} \times 100$$

5.7.3 Convert mm mercury (mmHG) to inches mercury (inHG)

$$mmHG = inHG \times 25.4$$

5.7.4 True Barometric Pressure

For converting BP obtained from a public domain source that is expressed in BP at sea level to BP at the subject site.

$$TrueBP = (BP) - \frac{(2.5 \times [Local\ Altitude])}{100}$$

Where: BP is in mmHG and Local Altitude is in feet

Example: BP at site A is 30.49 inHg and elevation is 544 feet, calculate TrueBP

Convert inHG to mmHg:

$$\text{mmHg} = 30.49 \text{ inHg} \times 25.4 = 774.4 \text{ mmHg}$$

Calculate True BP:

$$\text{TrueBP} = (774.4 \text{ mmHg}) - [2.5 * (544 / 100)] = 774.4 - 13.6 = 760.8 \text{ mmHg}$$

6.0 RECORDS

Data will be recorded promptly, legibly, and in indelible ink on the appropriate logbooks and forms. At the completion of a field effort, all logbooks, field data forms, and calibration logs shall be scanned and made electronically available to the project team. The original field forms, calibrations logs, and log book will be maintained in the project file.

7.0 HEALTH AND SAFETY

Detailed Health and Safety requirements can be found in the site specific Health and Safety Plan. Ensure that a Safe Work Assessment and Permit form is filled out daily prior to any work in the field and reviewed with all project personnel in a daily safety brief.

Safety glasses with side shields or goggles and disposable gloves shall be worn during calibration activities.

8.0 REFERENCES

None

9.0 ATTACHMENTS

Attachment 1: Example Field Instrument Calibration Form

Attachment 2: Solubility of Oxygen at Given Temperatures

Attachment 3: Example Field Data Form

Attachment 1
Example Field Instrument Calibration Form

Field Instrument Calibration Form

Calibrated by: _____
Date: _____

Equipment (Make/Model/Serial#): _____
Equipment (Make/Model/Serial#): _____

pH (su) Standard: ± 0.2 standard units				DO (mg/L) Standard: ± 0.3 mg/L of theoretical*			
Initial Calibration		Initial Calibration Verification		IC (Temp:)		ICV (Temp:)	
Hach SL	Reading	Pine SL	Reading	Saturation (%)	Reading (%)	Theoretical (mg/L)	Reading (mg/L)
pH7				100			
pH4				CCV (Temp:)			
Continuing Calibration Verification				Saturation (%)	Reading (%)	Deviation	Acceptable Variance (Y/N)
Hach SL	Reading	Deviation	Acceptable Variance (Y/N)	100			
pH7				Theoretical (mg/L)	Reading (mg/L)	Deviation	Acceptable Variance (Y/N)
pH4							
ORP (mV) Standard: NA				Turbidity (ntu) Standard: $\pm 10\%$ of Standard			
IC (Zobell SL:)		ICV (Pine SL:)		Initial Calibration			
TCS (Std/Temp)	Reading	TCS (Std/Temp)	Reading	Standard		Reading	
CCV (Zobell SL:)				Continuing Calibration Verification			
TCS (Std/Temp)	Reading	Deviation	Acceptable Variance (Y/N)	Standard	Reading	Deviation	Acceptable Variance (Y/N)
Conductivity ($\text{ms}^{\text{C}}/\text{cm}$) Standard: $\pm 5\%$ of standard value				Comments:			
IC (YSI SL:)		ICV (Pine SL:)					
Standard	Reading	Standard	Reading				
CCV (YSI SL:)							
Standard	Reading	Deviation	Acceptable Variance (Y/N)				

Notes: SL solution lot su standard units ntu Nephelometric Turbidity Units
TCS temperature corrected standard mV millivolts °C degrees Celsius
Std standard % percent $\text{ms}^{\text{C}}/\text{cm}$ millisiemens per centimeter (temperature corrected)
Temp temperature mg/L milligrams per liter * Theoretical value

Attachment 2
Solubility of Oxygen at Given Temperatures

Field Measurement of Dissolved Oxygen

Solubility of Oxygen in Water at Atmospheric Pressure			
Temperature	Oxygen Solubility	Temperature	Oxygen Solubility
°C	mg/L	°C	mg/L
0.0	14.621	26.0	8.113
1.0	14.216	27.0	7.968
2.0	13.829	28.0	7.827
3.0	13.460	29.0	7.691
4.0	13.107	30.0	7.559
5.0	12.770	31.0	7.430
6.0	12.447	32.0	7.305
7.0	12.139	33.0	7.183
8.0	11.843	34.0	7.065
9.0	11.559	35.0	6.950
10.0	11.288	36.0	6.837
11.0	11.027	37.0	6.727
12.0	10.777	38.0	6.620
13.0	10.537	39.0	6.515
14.0	10.306	40.0	6.412
15.0	10.084	41.0	6.312
16.0	9.870	42.0	6.213
17.0	9.665	43.0	6.116
18.0	9.467	44.0	6.021
19.0	9.276	45.0	5.927
20.0	9.092	46.0	5.835
21.0	8.915	47.0	5.744
22.0	8.743	48.0	5.654
23.0	8.578	49.0	5.565
24.0	8.418	50.0	5.477
25.0	8.263		

Notes:

The table provides three decimals to aid interpolation

Under equilibrium conditions, the partial pressure of oxygen in air-saturated water is equal to that of the oxygen in water saturated

°C = degrees Celsius

mg/L = milligrams per liter

Attachment 3
Example Field Data Form

WELL DEVELOPMENT & GROUNDWATER SAMPLING FORM		
DATE:	JOB NUMBER:	EQUIPMENT (Make/Model #/Serial #):
PROJECT:	EVENT:	/ /
WELL ID:	LOCATION:	/ /
WEATHER CONDITIONS:	AMBIENT TEMP:	/ /
REVIEWED BY:	PERSONNEL:	/ /

WELL DIA:	WELL DEVELOPMENT	
TOTAL DEPTH from TOC (ft.):	START:	FINISH:
DEPTH TO WATER from TOC (ft.):	VOLUME PURGED (gal):	
LENGTH OF WATER COL. (ft.):	GROUNDWATER SAMPLING	
1 VOLUME OF WATER (gal):	START:	FINISH:
3 VOLUMES OF WATER (gal):	VOLUME PURGED (gal):	
	ANALYSIS:	

WELL DEVELOPMENT PARAMETERS		GW SAMPLING PARAMETERS	
Temperature:	± 1.0° C	Temperature:	± 0.2° C
pH:	± 0.5 standard units	pH:	± 0.2 standard units
Specific Conductance:	± 10% of the past measurement	Specific Conductance:	± 5% of the past measurement
Turbidity:	relatively stable	DO:	≤ 20% saturation
		ORP:	± 10 millivolts
		Turbidity:	≤ 10 NTU

IN-SITU TESTING

Circle one: DEVELOPMENT SAMPLING	<input type="checkbox"/> Bailer <input type="checkbox"/> Pump	Description:
Time (hh:mm):		
pH (units):		
Conductivity (mS/cm):		
Turbidity (NTU):		
DO (mg/L): YSI 556		
DO (mg/L): YSI 550		
Temperature (C°):		
ORP (mV):		
Volume Purged (gal):		
Depth to Water (ft):		
		Well Goes Dry While Purging <input type="checkbox"/>

SAMPLE DATA

Sample ID	Date (m/d/y)	Time (hh:mm)	Bottles (total to lab)	Filtered (0.45 µm)	Remarks

Purging/Sampling Device Decon Process:

COMMENTS:

Purge water placed in drum# _____

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Subsurface Soil Sampling by Split Spoon

Procedure 3-33

1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the methods used in obtaining subsurface soil samples using a split spoon for physical and/or chemical analysis. Subsurface soil samples are obtained in conjunction with soil boring programs and provide information as to the physical and/or chemical makeup of the subsurface environment. Specific information regarding sampling locations can be found in the associated Sampling and Analysis Plan (SAP).
- 1.2 The purpose of this SOP is to provide a description of a specific method or procedure to be used in the collection of subsurface soil samples. Subsurface soil is defined as unconsolidated material which may consist of one or a mixture of the following materials: sand, gravel, silt, clay, peat (or other organic soils), and fill material. Subsurface soil sampling, conducted in accordance with this SOP will promote consistency in sampling and provide a basis for sample representativeness.
- 1.3 This SOP covers subsurface soil sampling by split-spoon only, as this is the means most often used for obtained samples of unconsolidated deposits. Other types of equipment are available for use in subsurface soil sampling, including thin-wall tube samplers (Shelby tubes), piston samplers, and continuous core barrel samplers. Information on the use of these other sampling devices may be found in several available drilling handbooks and respective state and/or federal agency technical guidance documents. The American Society for Testing and Materials (ASTM) also provides procedures for use of split-spoon and other sampling devices.
- 1.4 Split-spoon subsurface soil sampling generally requires use of a drilling rig and typically the hollow-stem auger (HSA) or other common drilling method to generate a borehole in which to use the split-spoon sampler. The split-spoon sampler is inserted through the augers (or other type of drill casing) then is driven into the subsurface soil with a weighted hammer. The sampler is then retrieved and opened to reveal the recovered soil sample. Soil samples may be collected at a continuous interval or at pre-selected vertically spaced intervals within the borehole.
- 1.5 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).
- 1.6 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review. If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to surface water sampling then those procedures may be added as an appendix to the project specific SAP.
- 1.7 It is fully expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be approved in advance by the Program Quality Manager. Deviations to this SOP will be documented in the field records.

2.0 Safety

- 2.1** Depending upon the site-specific contaminants, various protective programs must be implemented prior to sampling the first location. All **field sampling personnel** responsible for sampling activities must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the sampling tasks. Conduct preliminary area monitoring to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor and liquid phase through the use of respirators and disposable clothing.
- 2.2** In addition, observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection during well sampling activities includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves, rubberized steel-toed boots, and an American National Standards Institute-standard hard hat. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on the contaminant concentrations, and shall always be available on site.
- 2.3** Daily safety briefs will be conducted at the start of each working day before any work commences. These daily briefs will be facilitated by the **Site Safety Officer (SSO)** or designee to discuss the day's events and any potential health risk areas covering every aspect of the work to be completed. Weather conditions are often part of these discussions. As detailed in the HASP, everyone on the field team has the authority to stop work if an unsafe condition is perceived until the conditions are fully remedied to the satisfaction of the SSO.
- 2.4** The health and safety considerations for the work associated with split spoon sampling include:
- To avoid lifting injuries associated with carrying split spoons and associated drilling/sampling equipment, use large muscles of the legs, not the back.
 - Stay clear of all moving equipment, and avoid wearing loose fitting clothing.
 - To avoid heat/cold stress as a result of exposure to extreme temperatures and PPE, drink electrolyte replacement fluids (1 to 2 cups per hour is recommended) and in case of extreme cold, wear fitted insulated clothing.
 - Be aware of restricted mobility due to PPE.
 - At no point should soil samples be put into the mouth.

3.0 Terms and Definitions

None.

4.0 Interference

Potential interferences could result from cross-contamination between samples or sample locations. Minimization of the cross contamination will occur through the following:

- The use of clean sampling tools at each location as necessary.
- Avoidance of material that is not representative of the media to be sampled.
- Extreme temperatures or humidity can affect the reliability of certain field screening equipment, such as photoionization detectors (PID).
- If screening soil samples for headspace readings in extreme cold temperatures, samples may need to be warmed slightly prior to screening.

5.0 Training and Qualifications

5.1 Qualifications and Training

- 5.1.1 The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 Responsibilities

- 5.2.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that split spoon sampling activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all field sampling personnel involved in split spoon sampling shall have the appropriate education, experience, and training to perform their assigned tasks.
- 5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 5.2.3 The **Field Manager (FM)** is responsible for ensuring that all field sampling personnel follow these procedures.
- 5.2.4 **Field sampling personnel** are responsible for the implementation of this procedure. Minimum qualifications for field sampling personnel require that one individual on the field team shall have a minimum of 6 months of experience with split spoon sampling.
- 5.2.5 The **field sampler and/or task manager** is responsible for conducting split spoon soil sampling in a manner which is consistent with this SOP. The field sampler or designee will observe all activities pertaining to split spoon soil sampling to ensure that the SOP is followed, and to record all pertinent data onto a boring log. It is also the responsibility of the field sampler or designee to indicate the specific targeted sampling depth or sampling interval to the drilling subcontractor. The field sampler or designee is also responsible for the collection of representative environmental or stratigraphic characterization samples once the sampling device has been retrieved and opened. Additional sample collection responsibilities include labelling, handling, and storage of samples until further chain-of-custody procedures are implemented. If deviations from the procedure are required because of anomalous field conditions, they must first be approved by the Program Quality Manager and then documented in the field logbook and associated report or equivalent document.
- 5.2.6 It will be the responsibility of the **drilling subcontractor** to provide the necessary materials for obtaining subsurface soil samples. This generally includes one or more split-spoon samplers in good operating condition and sample containers used for stratigraphic characterization samples (sample containers for environmental samples should be provided by the designated analytical laboratory). It is the drilling subcontractor's responsibility to provide and maintain their own boring logs if desired. Equipment decontamination materials should also be supplied by the subcontractor and should meet project specifications.
- 5.2.7 Sampling personnel will also be health and safety trained and certified as specified in the HASP.

6.0 Equipment and Supplies

In addition to those materials provided by the subcontractor, the following equipment list contains materials which may be needed in carrying out the procedures outlined in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- SAP and HASP
- Personal protective equipment (PPE) and other safety equipment, as required by the HASP
- Boring logs
- Teaspoon or spatula (stainless steel is recommended)

- Sample kit (bottles, labels, custody records and tape, cooler with ice)
- Folding rule or tape measure
- Equipment decontamination materials
- Geologist Table
- Field logbook and pen with indelible ink

7.0 Calibration or Standardization

Field screening instruments (eg. PIDs) should be calibrated following manufacturer's instructions prior to the start of work and as a set time interval throughout the day. Calibration information should be recorded in the field log book or on a calibration log form.

8.0 Procedure

8.1 General Method Description

Split-spoon sampling devices are typically constructed of steel and are most commonly available in lengths of 18 and 24 inches and diameters of 1.5 to 3 inches. The split-spoon consists of a tubular body with two halves that split apart lengthwise, a drive head on the upper end with a ball-check valve for venting, and a hardened steel cutting shoe at the bottom. The soil sample enters the split-spoon through the cutting shoe as the device is driven into the ground. A replaceable plastic or metal basket is often inserted into the shoe to assist with retaining samples. Once the sampler is retrieved, the drive head and cutting shoes are removed and the split-spoon halves are then separated, revealing the sample.

Sample depth intervals are usually defined on a project-specific basis with these requirements specified in the project sampling plan. Sampling intervals typically range from one (1) sample per five (5) feet of drilling to continuous sampling where the entire drilled interval is sampled.

Subsurface soil sampling is usually accomplished as part of a drilling program where a soil boring is advanced with drilling equipment to the designated depth prior to collection of a representative sample. The general procedures outlined briefly in the following section provide requirements for advancing drill casing/augers in preparation for sampling.

8.2 General Procedures - Borehole Preparation

8.2.1 Advancing Casing/Augers

Soil borings that are completed for soil sampling purposes are typically advanced using hollow-stem augers and sometimes drive-and-wash or other casing methods. The casing/augers must be of sufficient diameter to allow for soil sampling at a minimum. The casing/augers will be advanced according to project requirements to the required depth for sampling. If hollow-stem augers are used, a temporary plug shall be used in the lead auger to prevent the auger from becoming filled with drill cuttings while drilling is in progress.

8.2.2 Obstructions

For those borings which encounter obstructions, the casing/augers will be advanced past or through the obstruction if possible. Caution should be exercised when obstructions are encountered and an effort made to identify the obstruction before drilling is continued. If the obstruction is not easily drilled through or removed, the boring should be relocated to an adjacent location.

8.2.3 Use of Added Water

The use of added or recirculated water during drilling is permitted when necessary. Use of extraneous water should be minimized or avoided if possible as it may impact sample quality. Water usage should be documented in the field notebook. Sampling and analysis of added or recirculated water may be

required for quality assurance purposes (refer to SAP). If a well is installed within the completed borehole, removal of the added water may be required. State and/or local permitting may be required for adding water to the subsurface.

8.3 Sampling Procedure

8.3.1 Equipment Decontamination

Each split-spoon must be decontaminated prior to its initial use and following collection of each soil sample. Equipment decontamination procedures should be performed in accordance with SOP 3-06 – Equipment Decontamination. Any additional site-specific requirements for equipment decontamination will be outlined in the SAP.

8.3.2 Standard Penetration Test

The drilling subcontractor will lower the split-spoon into the borehole. Samples are generally obtained using the Standard Penetration Test (SPT) in accordance with ASTM standards (ASTM D 1586-84). Following this method, the sampler will be driven using the 140-pound hammer with a vertical free drop of 30 inches using two turns of the rope on the cathead. The number of hammer blows required for every 6 inches of penetration will be recorded on the boring log. Blowcount information is used as an indicator of soil density for geotechnical as well as stratigraphic logging purposes. Once the split-spoon has been driven to its fullest extent, or to refusal, it will be removed from the borehole.

8.3.3 Sample Recovery

The split-spoon will be immediately opened upon removal from the casing/auger. The open sampler should be screened for volatile organics with a photoionization device (PID) if required by the SAP. If the SAP also requires individual soil sample headspace screening for volatile organic compounds (VOCs), the procedure should be performed according to SOP 3-19 Headspace Screening for VOCs.

Sample recovery will be determined by the project geologist or designee who will examine the soil core once the sampler is opened. The length of sample shall then be measured with a folding rule or tape measure. Any portion of the split-spoon contents which are not considered part of the true sample (i.e., heaved soils) will be discarded. If the sample recovery is considered inadequate for sample characterization or analytical testing purposes, another sample should be collected from the next vertical interval if possible before drilling is reinitiated.

Adequate sample recovery for stratigraphic logging and/or headspace screening for VOCs purposes should be approximately 6 inches. Adequate sample recovery for analytical testing purposes should be a minimum of 12 inches and is somewhat dependent on the type of analytical testing required. In some cases, continuous sampling over a short interval, and compositing of the sample, may be required to satisfy analytical testing requirements. Larger diameter samplers may be used if large volumes of soil are required for analytical testing.

8.3.4 Sample Containment - General

Once retrieved, the sample will be removed from the split-spoon with a teaspoon or spatula and placed into the appropriate sample container. The sample will be split if necessary to meet sampling program requirements. Sample splitting may be necessary to provide individual samples for headspace testing, visual characterization, physical testing, analytical testing, or simply for archiving purposes. In general, most sampling programs are structured around environmental characterization needs; therefore, sample portions required for analytical testing should be collected first. The SAP will provide specific sample container requirements for each type of sample and should be referred to for guidance.

Once filled, the sample containers should be properly capped, cleaned, and labeled, and chain-of-custody and sample preservation procedures initiated. Sampling equipment should then be properly decontaminated.

8.3.5 Sample Containment - Volatile Organic Analyses

Collection of subsurface soil samples for VOCs is more complex than collection of samples for other routine chemical or physical testing primarily because of the concern for the potential loss of volatiles during the sample collection procedure. To limit the potential for loss of volatiles, the soil sample needs to be obtained as quickly and as directly as possible from the split-spoon. This generally means that the VOC sample is collected and placed into the appropriate sample container first. The VOC sample should also be obtained from a discrete portion of the entire sample interval and not composited or homogenized. The remainder of the recovered sample can then be composited, homogenized or split to meet the other testing requirements. The boring log and/or sample logbook should be filled out to indicate actual sample collection depths for both VOA samples and other portions of the sample which may have been composited over a larger vertical interval.

9.0 Quality Control and Assurance

- 9.1** Sampling personnel should follow specific quality assurance guidelines as outlined in the site-specific SAP. Proper quality assurance requirements should be provided which will allow for collection of representative samples from representative sampling points. Quality assurance requirements outlined in the SAP typically suggest the collection of a sufficient quantity of field duplicate, field blank, and other samples.
- 9.2** Quality control requirements are dependent on project-specific sampling objectives. The SAP will provide requirements for sample preservation and holding times, sample container types, sample packaging and shipment, as well as requirements for the collection of various quality assurance samples such as trip blanks, field blanks, equipment blanks, and field duplicate samples.

10.0 Data Records and Management

- 10.1** Records will be maintained in accordance with SOP 3-03 Recordkeeping, Sample Labelling, and Chain-of-Custody. Various forms are required to ensure that adequate documentation is made of sample collection activities. These forms include:
- Boring logs and/or electronic data collection devices
 - Field log books
 - Chain-of-custody records
 - Shipping labels
- Original copies of these records should be maintained in the appropriate project files.
- 10.2** Boring logs (Attachment 1) will provide visual and descriptive information for each sample collected and are often the most critical form of documentation generated during a sampling program. Field electronic data collection devices (e.g., Yuma Tablet, Toughbook Laptop) with data collection software may also be used to record boring log information.
- 10.3** The field log book is kept as a general log of activities.
- 10.4** Chain-of-custody forms are transmitted with the samples to the laboratory for sample tracking purposes.
- 10.5** Shipping labels are required if sample coolers are to be transported to the laboratory by a third party (courier service).

11.0 Attachments or References

Attachment 1 – Boring Log


ASTM D 1586-84 Subsurface Exploration Using the Standard Penetration Test and the Cone Penetrometer Test

SOP 3-03 Recordkeeping, Sample Labeling, and Chain-of-Custody

SOP 3-06 Equipment Decontamination

<i>Author</i>	<i>Reviewer</i>	<i>Revisions (Technical or Editorial)</i>
Robert Shoemaker Senior Scientist	Naomi Ouellette, Project Manager	Rev 0 – Initial Issue

Attachment 1 Boring Log

 RESOLUTION CONSULTANTS		Client: _____				Boring ID: _____			
		Project Number: _____							
		Site Location: _____				Sheet: 1 of 1			
		Coordinates: _____		Elevation: _____					
		Drilling Method: _____				Monitoring Well Installed: _____			
		Sample Type(s): _____				Boring Diameter: _____		Screened Interval: _____	
Weather: _____				Logged By: _____		Date/Time Started: _____		Depth of Boring: _____	
Drilling Contractor: _____				Ground Elevation: _____		Date/Time Finished: _____		Water Level: _____	
Depth (ft)	Geologic Sample ID	Sample Depth (ft)	Blows per 6"	Recovery (inches)	Headspace (ppm)	U S C S	MATERIALS: Color, size, range, MAIN COMPONENT, minor component(s), moisture content, structure, angularity, maximum grain size, odor, and Geologic Unit (if Known)	Lab Sample ID	Lab Sample Depth (ft.)
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
NOTES: _____ Checked by: _____ Date: _____							Date	Time	Depth to groundwater while drilling

Appendix B

TestAmerica ELAP Certification



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

TESTAMERICA DENVER
4955 Yarrow Street
Arvada, CO 80002
Margaret S. Sleeve Phone: 303-736-0100
www.testamericainc.com

ENVIRONMENTAL

Valid To: October 31, 2015

Certificate Number: 2907.01

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 4.2 of the DoD Quality Systems Manual for Environmental Laboratories), and for the test methods applicable to the Wyoming Storage Tank Remediation Laboratory Accreditation Program, accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below:

Testing Technologies

Atomic Absorption/ICP-AES Spectrometry, ICP/MS, Gas Chromatography, Gas Chromatography/Mass Spectrometry, Gravimetry, High Performance Liquid Chromatography, Ion Chromatography, Misc.- Electronic Probes (pH, O₂), Oxygen Demand, Hazardous Waste Characteristics Tests, Spectrophotometry (Visible), Spectrophotometry (Automated), Titrimetry, Total Organic Carbon, Total Organic Halide

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
<u>Metals</u>				
Aluminum	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Antimony	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Arsenic	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Barium	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Beryllium	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Boron	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Cadmium	EPA 6010C	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A

Peter Mlyne

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Calcium	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Chromium	EPA 6010C	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Cobalt	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Copper	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Iron	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Lead	EPA 6010C	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Lithium	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Magnesium	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Manganese	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Mercury	-----	-----	EPA 7470A	EPA 7471A / 7471B
Molybdenum	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Nickel	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Potassium	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Selenium	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Silica	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Silicon	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Silver	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Sodium	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Strontium	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Thallium	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Tin	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Titanium	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Vanadium	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Zinc	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
<u>Nutrients</u>				
Nitrate (as N)	-----	By calculation	By calculation / EPA 9056 / 9056A	By calculation / EPA 9056 / 9056A
Nitrate-nitrite (as N)	-----	EPA 353.2	EPA 353.2 / 9056 / 9056A	EPA 9056 / 9056A
Nitrite (as N)	-----	SM 4500-NO2 B	SM 4500-NO2 B; EPA 9056 / 9056A	EPA 9056 / 9056A
Orthophosphate (as P)	-----	-----	EPA 9056 / 9056A	EPA 9056 / 9056A
Total phosphorus	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
<u>Demands</u>				
Total Organic Carbon	-----	-----	EPA 9060 / 9060A	EPA 9060 / 9060A
Total Organic Halides	-----	-----	EPA 9020B	-----
<u>Wet Chemistry</u>				-----
Alkalinity (Total Bicarbonate, Carbonate, and Hydroxide Alkalinity)	-----	SM 2320 B_1997	SM 2320 B	SM 2320 B
Ammonia	-----	EPA 350.1	EPA 350.1	-----
Biological Oxygen Demand	-----	SM 5210B	SM 5210B	-----
Bromide	-----	-----	EPA 9056 / 9056A	EPA 9056 / 9056A
Chloride	-----	-----	EPA 9056 / 9056A	EPA 9056 / 9056A
Chemical Oxygen Demand	-----	EPA 410.4	EPA 410.4	
Conductivity	-----	-----	EPA 9050 / 9050A	EPA 9050 / 9050A
Cyanide	-----	-----	9012A / 9012B	9012A / 9012B
Ferrous Iron	-----	SM 3500 Fe B, D	SM 3500 Fe B, D	-----
Fluoride	-----	-----	EPA 9056 / 9056A	EPA 9056 / 9056A
Hexavalent Chromium	EPA 7196A	-----	EPA 7196A	-----
pH	-----	-----	EPA 9040B / 9045C	EPA 9040B / 9045C
Oil and Grease (HEM and SGT-HEM)	-----	-----	EPA 1664A/ 1664B	9071B
Percent Moisture	-----	-----	-----	ASTM D2216
Perchlorate	-----	-----	EPA 6860	EPA 6860
Phenols	-----	-----	EPA 9066	EPA 9066
Solids, Total	-----	SM 2540 B	SM 2540 B	SM 2540 B
Solids, Total Suspended	-----	SM 2540 D	SM 2540 D	SM 2540 D
Solids, Total Dissolved	-----	SM 2540 C	SM 2540 C	SM 2540 C
Sulfate	-----	-----	EPA 9056 / 9056A	EPA 9056 / 9056A
Sulfide, Total	-----	-----	EPA 9034	EPA 9034
Sulfide	-----	-----	EPA 9030B	EPA 9030B
Total Kjeldahl Nitrogen	-----	-----	EPA 351.2	-----

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
<u>Purgeable Organics (volatiles)</u>				-----
Acetone	-----	-----	EPA 8260B	EPA 8260B
Acetonitrile	-----	-----	EPA 8260B	EPA 8260B
Acrolein	-----	-----	EPA 8260B	EPA 8260B
Acrylonitrile	-----	-----	EPA 8260B	EPA 8260B
Allyl Chloride	-----	-----	EPA 8260B	EPA 8260B
tert-Amyl Methyl Ether	EPA 8260B			
Benzene	EPA 8260B / 8021B	-----	EPA 8260B / 8021B / AK101/ OK DEQ GRO	EPA 8260B / 8021B / AK101/ OK DEQ GRO
Bromobenzene	-----	-----	EPA 8260B	EPA 8260B
Bromochloromethane	-----	-----	EPA 8260B	EPA 8260B
Bromodichloromethane	-----	-----	EPA 8260B	EPA 8260B
Bromoform	-----	-----	EPA 8260B	EPA 8260B
Bromomethane	-----	-----	EPA 8260B	EPA 8260B
2-Butanone	-----	-----	EPA 8260B	EPA 8260B
n-Butyl alcohol	-----	-----	EPA 8260B / 8015B / 8015C	EPA 8260B / 8015B / 8015C
tert-Butyl alcohol	EPA 8260B			
n-Butylbenzene	-----	-----	EPA 8260B	EPA 8260B
sec-Butylbenzene	-----	-----	EPA 8260B	EPA 8260B
tert-Butylbenzene	-----	-----	EPA 8260B	EPA 8260B
Carbon disulfide	-----	-----	EPA 8260B	EPA 8260B
Carbon tetrachloride	-----	-----	EPA 8260B	EPA 8260B
Chlorobenzene	-----	-----	EPA 8260B / 8021B	EPA 8260B / 8021B
2-Chloro-1,3-butadiene	-----	-----	EPA 8260B	EPA 8260B
Chloroethane	-----	-----	EPA 8260B	EPA 8260B
2-Chloroethyl vinyl ether	-----	-----	EPA 8260B	EPA 8260B
Chloroform	-----	-----	EPA 8260B	EPA 8260B
1-Chlorohexane	-----	-----	EPA 8260B	EPA 8260B
Chloromethane	-----	-----	EPA 8260B	EPA 8260B
Chloroprene	-----	-----	EPA 8260B	EPA 8260B
4-Chlorotoluene	-----	-----	EPA 8260B	EPA 8260B
2-Chlorotoluene	-----	-----	EPA 8260B	EPA 8260B
Cyclohexane	-----	-----	EPA 8260B	EPA 8260B
Cyclohexanone	-----	-----	EPA 8260B	EPA 8260B
Dibromochloromethane	-----	-----	EPA 8260B	EPA 8260B
1,2-Dibromo-3-chloropropane (DBCP)	-----	EPA 504	EPA 504 / 8260B / 8011	EPA 8260B / 8011
Dibromochloromethane	-----	-----	EPA 8260B	EPA 8260B
Dichlorodifluoromethane	-----	-----	EPA 8260B	EPA 8260B
Dibromomethane	-----	-----	EPA 8260B	EPA 8260B
1,2 Dibromoethane (EDB)	EPA 8011	EPA 504	EPA 504 / 8260B / 8011	EPA 8260B / 8011
1,2-Dichlorobenzene	-----	-----	EPA 8260B / 8021B	EPA 8260B / 8021B
1,3-Dichlorobenzene	-----	-----	EPA 8260B / 8021B	EPA 8260B / 8021B

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
1,4-Dichlorobenzene	-----	-----	EPA 8260B / 8021B	EPA 8260B / 8021B
cis-1,4-Dichloro-2-butene	-----	-----	EPA 8260B	EPA 8260B
trans-1,4-Dichloro-2-butene	-----	-----	EPA 8260B	EPA 8260B
1,1-Dichloroethane	-----	-----	EPA 8260B	EPA 8260B
1,2-Dichloroethane	EPA 8260B	-----	EPA 8260B	EPA 8260B
1,1-Dichloroethene	-----	-----	EPA 8260B	EPA 8260B
1,2-Dichloroethene	-----	-----	EPA 8260B	EPA 8260B
cis-1,2-Dichloroethene	-----	-----	EPA 8260B	EPA 8260B
trans-1,2-Dichloroethene	-----	-----	EPA 8260B	EPA 8260B
Dichlorofluoromethane	-----	-----	EPA 8260B	EPA 8260B
1,2-Dichloropropane	-----	-----	EPA 8260B	EPA 8260B
1,3-Dichloropropane	-----	-----	EPA 8260B	EPA 8260B
2,2-Dichloropropane	-----	-----	EPA 8260B	EPA 8260B
1,1-Dichloropropene	-----	-----	EPA 8260B	EPA 8260B
1,3-Dichloropropene	-----	-----	EPA 8260B	EPA 8260B
cis-1,3-Dichloropropene	-----	-----	EPA 8260B	EPA 8260B
trans-1,3-Dichloropropene	-----	-----	EPA 8260B	EPA 8260B
Diethyl ether	-----	-----	EPA 8260B	EPA 8260B
Di-isopropylether	EPA 8260B	-----	EPA 8260B	EPA 8260B
1,4-Dioxane	-----	-----	EPA 8260B / 8260B SIM	EPA 8260B / 8260B SIM
Ethanol	-----	-----	EPA 8260B / 8015B / 8015C	EPA 8260B / 8015B / 8015C
Ethyl Acetate	-----	-----	EPA 8260B	EPA 8260B
Ethyl Benzene	EPA 8260B/8021B	-----	EPA 8260B / 8021B / AK101/ OK DEQ GRO	EPA 8260B / 8021B/ AK101/ OK DEQ GRO
Ethyl Methacrylate	-----	-----	EPA 8260B	EPA 8260B
Ethyl tert-Butyl Ether	EPA 8260B			
Ethylene Glycol	-----	-----	EPA 8015C	EPA 8015C
Gas Range Organics (GRO)	EPA 8015C	-----	EPA 8015B / 8015C / AK101 / 8015D	EPA 8015B / 8015C / AK101 / 8015D
Hexane	-----	-----	EPA 8260B	EPA 8260B
2-Hexanone	-----	-----	EPA 8260B	EPA 8260B
Hexachlorobutadiene	-----	-----	EPA 8260B	EPA 8260B
Isobutyl Alcohol (2-Methyl-1-propanol)	-----	-----	EPA 8260B / 8015B / 8015C	EPA 8260B / 8015B / 8015C
Isopropyl Alcohol	-----	-----	EPA 8260B	EPA 8260B
Isopropylbenzene	-----	-----	EPA 8260B	EPA 8260B
1,4-Isopropyltoluene	-----	-----	EPA 8260B	EPA 8260B
Iodomethane	-----	-----	EPA 8260B	EPA 8260B
Methacrylonitrile	-----	-----	EPA 8260B	EPA 8260B
Methanol	-----	-----	EPA 8015B / 8015C	EPA 8015B / 8015C
Methyl Acetate	-----	-----	EPA 8260B	EPA 8260B
Methyl Cyclohexane	-----	-----	EPA 8260B	EPA 8260B
Methylene Chloride	-----	-----	EPA 8260B	EPA 8260B
Methyl Ethyl Ketone (MEK)	-----	-----	EPA 8260B	EPA 8260B
Methyl Isobutyl Ketone	-----	-----	EPA 8260B	EPA 8260B
Methyl Methacrylate	-----	-----	EPA 8260B	EPA 8260B

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Methyl tert-Butyl Ether (MtBE)	EPA 8260B / 8021B	-----	EPA 8260B / 8021B / OK DEQ GRO	EPA 8260B / 8021B/ OK DEQ GRO
4-Methyl-2-Pentanone	-----	-----	EPA 8260B	EPA 8260B
Naphthalene	EPA 8260B / 8021B	-----	EPA 8260B/ OK DEQ GRO	EPA 8260B / OK DEQ GRO
2-Nitropropane	-----	-----	EPA 8260B	EPA 8260B
2,2' Oxybisethanol	-----	-----	EPA 8015C	EPA 8015C
2-Pentanone	-----	-----	EPA 8260B	EPA 8260B
Propionitrile	-----	-----	EPA 8260B	EPA 8260B
n-Propylbenzene	-----	-----	EPA 8260B	EPA 8260B
Propylene Glycol	-----	-----	EPA 8015C	EPA 8015C
Styrene	-----	-----	EPA 8260B	EPA 8260B
1,1,1,2-Tetrachloroethane	-----	-----	EPA 8260B	EPA 8260B
1,1,2,2-Tetrachloroethane	-----	-----	EPA 8260B	EPA 8260B
Tetrachloroethene	-----	-----	EPA 8260B	EPA 8260B
Tetrahydrofuran	-----	-----	EPA 8260B	EPA 8260B
Toluene	EPA 8260B / 8021B	-----	EPA 8260B / 8021B / AK101 / OK DEQ GRO	EPA 8260B / 8021B / AK101 / OK DEQ GRO
Total Petroleum Hydrocarbons (TPH)	-----	EPA 1664A EPA 1664B	EPA 1664A EPA 1664B	-----
1,2,3-Trichlorobenzene	-----	-----	EPA 8260B	EPA 8260B
1,1,1-Trichloroethane	-----	-----	EPA 8260B	EPA 8260B
1,1,2-Trichloroethane	-----	-----	EPA 8260B	EPA 8260B
Trichloroethene	-----	-----	EPA 8260B	EPA 8260B
Trichlorofluoromethane	-----	-----	EPA 8260B	EPA 8260B
1,2,3-Trichlorobenzene	-----	-----	EPA 8260B	EPA 8260B
1,2,4-Trichlorobenzene	-----	-----	EPA 8260B	EPA 8260B
1,2,3-Trichloropropane	-----	EPA 504.1	EPA 504.1 / 8260B / 8011	EPA 8260B / 8011
1,1,2-Trichloro-1,2,2-trifluoroethane	-----	-----	EPA 8260B	EPA 8260B
Triethylene Glycol	-----	-----	EPA 8015C	EPA 8015C
1,2,3-Trimethylbenzene	-----	-----	EPA 8260B	EPA 8260B
1,2,4-Trimethylbenzene	-----	-----	EPA 8260B	EPA 8260B
1,3,5-Trimethylbenzene	-----	-----	EPA 8260B	EPA 8260B
Vinyl Acetate	-----	-----	EPA 8260B	EPA 8260B
Vinyl Chloride	-----	-----	EPA 8260B	EPA 8260B
Xylenes, total	EPA 8260B / 8021B	-----	EPA 8260B / 8021B / AK101 / OK DEQ GRO	EPA 8260B / 8021B / AK101 / OK DEQ GRO
1,2-Xylene	EPA 8260B / 8021B	-----	EPA 8260B / 8021B / AK101 / OK DEQ GRO	EPA 8260B / 8021B / AK101 / OK DEQ GRO
M+P-Xylene	EPA 8260B / 8021B	-----	EPA 8260B / 8021B / AK101 / OK DEQ GRO	EPA 8260B / 8021B / AK101 / OK DEQ GRO
Methane	-----	-----	RSK-175	-----
Ethane	-----	-----	RSK-175	-----
Ethylene (Ethene)	-----	-----	RSK-175	-----
Acetylene	-----	-----	RSK-175	-----

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Acetylene Ethane	-----	-----	RSK-175	-----
<u>Extractable Organics (semivolatiles)</u>				
Acenaphthene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Acenaphthylene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Acetophenone	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Acetylaminofluorene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Alachlor	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Aminobiphenyl	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Aniline	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Anthracene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Aramite	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Atrazine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Azobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Benzaldehyde	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Benzidine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Benzoic acid	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Benzo (a) Anthracene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzo (b) Fluoranthene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzo (k) Fluoranthene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzo (ghi) Perylene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzo (a) Pyrene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzyl Alcohol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Bis (2-chloroethoxy) methane	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Bis (2-chloroethyl) Ether	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Bis (2-chloroisopropyl) Ether (2,2'Oxybis(1-chloropropane)	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Bis (2-ethylhexyl) Phthalate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Bromophenyl Phenyl Ether	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Butyl Benzyl Phthalate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-sec-Butyl-4,6-Dinitrophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Carbazole	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Chloroaniline	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Chlorobenzilate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Chloro-3-Methylphenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1-Chloronaphthalene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Chloronaphthalene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Chlorophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Chlorophenyl Phenyl Ether	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Chrysene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Cresols	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Diallate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Dibenzo (a,h) Anthracene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Dibenzofuran	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,2-Dichlorobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,3-Dichlorobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,4-Dichlorobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
3,3'-Dichlorobenzidine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4-Dichlorophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,6-Dichlorophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Diethyl phthalate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Dimethoate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
3,3-Dimethylbenzidine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D

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<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
p-Dimethylaminoazobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
7,12-Dimethylbenz(a)anthracene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Alpha-,alpha-Dimethylphenethylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4-Dimethylphenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Dimethyl Phthalate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Di-n-Butyl Phthalate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Di-n-Octyl Phthalate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,3-Dinitrobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,4-Dinitrobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4-Dinitrophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4-Dinitrotoluene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,6-Dinitrotoluene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,4-Dioxane	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Diphenylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,2-Diphenylhydrazine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Disulfoton	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Diesel Range Organics (DRO)	EPA 8015C	-----	EPA 8015B / 8015C, AK102, TX 1005 / 8015D / OK DEQ DRO	EPA 8015B / 8015C, AK102, TX 1005 / 8015D / OK DEQ DRO
Ethyl Methanesulfonate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Famphur	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Fluoroanthene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Fluorene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Gasoline Range Organics	-----	-----	TX 1005 / OK DEQ GRO	TX 1005 / OK DEQ GRO
Hexachlorobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Hexachlorobutadiene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Hexachlorocyclopentadiene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Hexachloroethane	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Hexachloropropene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Indeno (1,2,3-cd) Pyrene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Isodrin	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Isophorone	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Isosafrole	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Methapyrilene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
3-Methylcholanthrene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Methyl-4,6-Dinitrophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Methyl Methane Sulfonate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Methylcholanthrene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1-Methylnaphthalene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
2-Methylnaphthalene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
2-Methylphenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
3+4-Methylphenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Naphthalene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
1,4-Naphthoquinone	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1-Naphthylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Naphthylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Nitroaniline	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
3-Nitroaniline	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Nitroaniline	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Nitrobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Nitrophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Nitrophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Nitroquinoline-1-Oxide	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
N-Nitrosodiethylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosodimethylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosodi-n-Butylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosodi-n-Propylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosodiphenylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosomethylethylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosomorpholine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosopiperidine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosopyrrolidine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
5-Nitro-o-Toluidine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,2-oxybis(1-chloropropane)	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Parathion, Methyl	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Parathion, Ethyl	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Pentachlorobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Pentachloroethane	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Pentachloronitobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Pentachlorophenol	-----	-----	EPA 8270C / 8270D / 8321A / 8321B	EPA 8270C / 8270D / 8321A / 8321B
Phenacetin	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Phenanthrene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Phenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Phorate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Picoline	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Pronamide	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Pyrene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Pyridine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Safrole	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Sulfotepp	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,2,4,5-Tetrachlorobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,3,4,6-Tetrachlorophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Thionazin	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
o-Toluidine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,2,4-Trichlorobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4,5-Trichlorophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4,6-Trichlorophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
o,o,o-Triethyl Phosphorothioate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,3,5-Trinitrobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Motor Oil (Residual Range Organics)	-----	-----	EPA 8015B / 8015C, AK103 / OK DEQ RRO	EPA 8015B / 8015C, AK103 / OK DEQ RRO
<u>Pesticides/Herbicides/PCBs</u>				
Aldrin	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Atrazine	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Azinophos ethyl	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Azinophos methyl	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
alpha-BHC	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
beta-BHC	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
delta-BHC	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
gamma-BHC	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Bolstar	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
alpha-Chlordane	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
gamma-Chlordane	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Chlordane (technical)	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Chloropyrifos	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Coumaphos	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
2,4-D	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A
Dalapon	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A
2,4-DB	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A
4,4'-DDD	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
4,4'-DDE	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
4,4'-DDT	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Demeton-O	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Demeton-S	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Demeton, total	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Diazinon	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Dicamba	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A
Dichlorovos	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Dichloroprop	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A
Dieldrin	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Dimethoate	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Dinoseb	-----	-----	EPA 8151A / 8321A	EPA 8321A
Disulfoton	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Endosulfan I	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Endosulfan II	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Endonsulfan sulfate	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Endrin	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Endrin aldehyde	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Endrin ketone	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
EPN	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Ethoprop	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Ethyl Parathion	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Famphur	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Fensulfothion	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Fenthion	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Heptachlor	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Heptachlor Epoxide	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Hexachlorobenzene	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Malathion	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
MCPA	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A
MCPP	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A
Merphos	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Methoxychlor	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Methyl parathion	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Mevinphos	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Naled	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
PCB-1016 (Arochlor)	-----	-----	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1221	-----	-----	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1232	-----	-----	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1242	-----	-----	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1248	-----	-----	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1254	-----	-----	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1260	-----	-----	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1262	-----	-----	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1268	-----	-----	EPA 8082 / 8082A	EPA 8082 / 8082A
Phorate	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Phosmet	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Propazine	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Ronnel	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Simazine	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Stiropfos	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Sulfotepp	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
2,4,5-T	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A
Thionazin	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Tokuthion	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
2,4,5-TP	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A
Toxaphene	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Trichloronate	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
o,o,o-Triethylphos Phorothioate	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
<u>Explosives</u>				
1,3,5-Trinitrobenzene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
1,3-Dinitrobenzene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
2,4,6-Trinitrotoluene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
3,5-Dinitroaniline	-----	-----	EPA 8330B	EPA 8330B
2,4-Dinitrotoluene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
2,6-Dinitrotoluene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
2-Amino-4,6-Dinitrotoluene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
2-Nitrotoluene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
3-Nitrotoluene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
4-Amino-2,6-Dinitrotoluene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
4-Nitrotoluene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Nitrobenzene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Nitroglycerin	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Octahydro-1,3,5,7-Tetrabito-1,3,5,7-Tetrazocine (HMX)	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Pentaerythritoltetranitrate (PETN)	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Picric acid	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
RDX (Hexahydro-1,3,5-Trinitro-1,3,5-Triazine)	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Tetryl (Methyl 2,4,6-Trinitrophenylnitramine)	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
<u>Perfluorinated Hydrocarbons (PFCs) and Perfluorinated Sulfonates (PFSs)</u>				
Perfluorobutanoic Acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluoropentanoic Acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorohexanoic Acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluoroheptanoic Acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorooctanoic Acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorononanoic Acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorodecanoic Acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluoroundecanoic Acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorododecanoic Acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorotridecanoic Acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorotetradecanoic Acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorobutane Sulfonate	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorohexane Sulfonate	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorooctane Sulfonate	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorodecane Sulfonate	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorooctane Sulfonamide	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
<u>Hazardous Waste Characteristics</u>				
Conductivity	-----	-----	EPA 9050A	EPA 9050A
Corrosivity	-----	-----	EPA 9040B	9045C
Ignitibility	-----	EPA 1010/EPA 1010A	EPA 1010 / 1010A	EPA 1010 / 1010A
Paint Filter Liquids Test	-----	-----	EPA 9095A	EPA 9095A
Synthetic Precipitation Leaching Procedure (SPLP)	-----	-----	EPA 1312	EPA 1312

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Toxicity Characteristic Leaching Procedure	-----	-----	EPA 1311	EPA 1311
<u>Organic Prep Methods</u>				
Separatory Funnel Liquid-Liquid Extraction	-----	-----	EPA 3510C	-----
Continuous Liquid-Liquid Extraction	-----	-----	EPA 3520C	-----
Soxhlet Extraction	-----	-----	-----	EPA 3540C
Microwave Extraction	-----	-----	-----	EPA 3546
Ultrasonic Extraction	-----	-----	-----	EPA 3550B
Ultrasonic Extraction	-----	-----	-----	EPA 3550C
Waste Dilution	-----	-----	EPA 3580A	EPA 3580A
Solid Phase Extraction Volatiles Purge and trap Volatiles Purge and Trap for Soils	-----	-----	EPA 3535A EPA 5030B	EPA 5030B EPA 5035
<u>Organic Cleanup Procedures</u>				
Florisil Cleanup	-----	-----	EPA 3620B	EPA 3620B
Florisil Cleanup	-----	-----	EPA 3620C	EPA 3620C
Sulfur Cleanup	-----	-----	EPA 3660B	EPA 3660B
Sulfuric Acid/Permanganate Cleanup	-----	-----	EPA 3665A	EPA 3665A
<u>Metals Digestion</u>				
Acid Digestion Total Recoverable or Dissolved Metals	-----	-----	EPA 3005A	-----
Acid Digestion for Total Metals	-----	-----	EPA 3010A	-----
Acid Digestion for Total Metals	-----	-----	EPA 3020A	-----
Acid Digestion of Sediments, Sludges and Soils	-----	-----	-----	EPA 3050B



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In recognition of the successful completion of the A2LA evaluation process that includes an assessment of the laboratory's compliance with ISO/IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 4.2 of the DoD Quality System Manual for Environmental Laboratories (QSM); accreditation is granted to this laboratory to perform recognized EPA methods as defined on the associated A2LA Environmental Scope of Accreditation. This accreditation demonstrates technical competence for this defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).



Presented this 5th day of November 2013.



President & CEO
For the Accreditation Council
Certificate Number 2907.01
Valid to October 31, 2015

For the tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.

Appendix C
Response to Comments

**NAVY RESPONSES TO
STATE OF MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION (MEDEP)
COMMENTS DATED JUNE 19, 2014
ON THE TIER II SAMPLING AND ANALYSIS PLAN,
PERFLUORINATED COMPOUNDS IN GROUNDWATER,
FORMER NAVAL AIR STATION, BRUNSWICK, MAINE
(MAY 6, 2014)**

The Navy's responses to MEDEP comments on the Navy's Tier II SAP, Perfluorinated Compounds in Groundwater, Former NAS Brunswick, Maine are presented below. MEDEP comments are presented first (in italics) followed by the Navy's responses.

MEDEP General Comments

General Comment 1: *MEDEP provided an extended comment in review of the Tier II SAP for Picnic Pond providing a rationale for justifying the reporting of the full standard list of PFCs as part of these investigations. Based on Navy's response that comment will not be repeated here, however for a nature and extent investigation it is shortsighted to restrict the reporting list before the extent of the problem is fully understood. Groundwater data from sites in Minnesota indicate that PFOA and PFOS may not represent the full extent of a PFC plume. If (or when) the treatment of these compounds at the GWETS is evaluated the full list must be reported to determine how the other PFCs may behave in or affect the treatment train.*

Response: At this time only PFOS and PFOA will be analyzed in groundwater samples. However, the SAP will be revised to include one round of sampling at the Groundwater Extraction Treatment System (GWETS) and analyzed for 16 PFCs. The proposed sampling will include an influent sample, a sample collected in the middle of the treatment process, and an effluent sample. The additional PFCs will be used to determine the effectiveness of the GWETS on treatment of various PFCs, not just PFOS and PFOA.

General Comment 2: *Please update the text and tables with any additional data or information that has come to light since the plan was drafted.*

Response: The SAP will be revised to include additional data and information since the submittal of the Draft SAP.

MEDEP Specific Comments

Specific Comment 3: Executive Summary, 2nd para: *"There are no toxicity values or standards established for PFOS and PFOA..." Please indicate that the Maine Center for Disease Control has developed human-health risk-based screening values for both PFOS and PFOA for exposures to soil, sediment, groundwater, surface water, and for the ingestion of fish.*

Response: Published human health risk-based screening levels are not available on the ME CDC's website as of September 11, 2014. However, the ME CDC has published a Maximum

Exposure Guideline (MEG) for PFOA in drinking water, which is 0.1 ug/L (<http://www.maine.gov/dhhs/mecdc/environmental-health/eohp/wells/documents/pfoameg.pdf>). The SAP will be updated to reflect the ME CDC MEG for PFOA. Until the ME CDC publishes a MEG for PFOS in drinking water, the MEG for PFOA will be used as a conservative value.

Specific Comment 4: Worksheet #9, Project Scoping Session, Bullet 14: Please clarify if Navy is now collecting monthly samples at GWETS for PFCs.

Response: Currently, PFCs are not collected as part of the monthly sampling program from the GWETS. However, the SAP will be revised to include one round of sampling from the GWETS and analyzed for 16 PFCs. The proposed sampling will include an influent sample, a sample collected in the middle of the treatment process, and an effluent sample. The additional PFCs will be used to determine the effectiveness of the GWETS on treatment of various PFCs, not just PFOS and PFOA.

Specific Comment 5: Section 10.4.1, Contaminant Release Mechanisms: Based on the Site 11 project file approximately 6 feet of soil were removed from the fire training site and placed in the Sites 1&3 landfill. This soil in addition to other waste placed in the landfill also represent a potential source (or past source) of PFCs to the environment.

Response: Based on disposal of Site 11 wastes at Landfill 1 & 3, this area is considered a potential source area. Worksheet 10 and Table 10-1 will be updated accordingly.

Specific Comment 6: Section 10.4.2, Contaminant Migration: Please clarify that the impacts of the release to the stormwater system noted in the MEDEP Spill Report were visually evaluated, no data were collected.

Response: The text will be updated to indicate that no analytical data were collected.

Specific Comment 7: Worksheet 11, Section 11.4, Table 11-1 and Figure 11-1:

- ***Site 11*** – Existing data from MW-1104 shows that shallow groundwater is impacted downgradient of the former fire training area, currently covered at least in part by the infiltration gallery. MW-323 shows that groundwater in the bedrock knob downgradient is impacted. Unless there is a strong need to show data at an in-between point, MW-306 or MW-306R could be used to collect lower sand data. To meet the objective of determining boundaries a sample location near the northern edge of the eastern plume or a point between the western edge of the plume and the former DRMO might be more useful than a new shallow well.

Response: The two proposed monitoring wells will be removed from the program. The proposed sampling program will be revised to include two alternate sampling points: 1) existing well MW-NASB-212 located at the northern edge of the Eastern Plume

just north of the western branch of Picnic Pond and 2) existing well MW-307 located south of Site 13 (DRMO) and west of the western edge of the Eastern Plume. The text, tables and figures will be updated accordingly.

- **Hanger 5** – *The proposed existing wells are screened in deeper sand units at top of clay (there is not a defined/confined lower sand in this area of the base) and may also indicate the flightline or Hanger 4 are potential sources based on groundwater flow direction. Please revise the table, MEDEP can provide boring logs if needed.*

Response: Table 11-1 will be revised to indicate that Hangar 5 wells MW09-001 and MW-NASB-227 are screened in the lower sand unit.

- **Building 555** – *The highest detections of PFCs at this building were in the upgradient well MW-6S (indicating an upgradient source, possibly Hanger 5) and at MW-4S near the southern edge of the property, where the highest soil PFCs were also detected. Groundwater elevations were fairly flat but did indicate shallow flow to the south. These data and low detections at MW-1S indicate that groundwater is impacted, and that perhaps a new location to the south of Building 555 and Orion Street is needed to support evaluation of migration from Hanger 5 and Building 555 toward the Eastern Plume or Landfill 1&3 area. If additional data is required for Building 555 then MW-4S appears to be most representative of direct impacts from this building.*

Response: Following the submittal of the SAP, PFC data related to a soil and groundwater investigation at Building 611/555 was made available. Based on review of the data, the proposed sampling program for wells in the vicinity of Building 555 will be revised. The revised sampling program will include: 1) sampling of existing wells MW-4S and MW-6S and 2) sampling of existing well MW-2101 located at the northern end of Sites 1 & 3, south of Orion Street. The text, tables and figures will be updated accordingly.

- *Based on the disposal of fire training area soils and other waste at Landfills 1&3, groundwater at that site should be added to this evaluation of nature and extent. A shallow/deep pair or a deep location near the slurry wall could be paired with one farther downgradient. Prior to the landfill cap and slurry wall the landfill may have contributed to PFCs found in the southern end of the Eastern Plume.*

Response: Based on disposal of Site 11 wastes at Landfill 1 & 3, this area is considered a potential source area. Additional discussion on September 10, 2014, Therefore, the SAP will be revised to include: 1) sampling of existing well MW-2101 located at the northern edge of the landfill, 2) sampling of existing well MW-216A located in the central portion of the landfill, 3) sampling of existing well MW-1&3-1301A located near the slurry wall and 4) sampling of existing well MW-240 located downgradient of the landfill.

Specific Comment 8: Worksheet 14, Drilling and Monitoring Well Installation: *The proposed methods may encounter difficulty with running sands if a deeper (lower sand) screen is completed downgradient of the former fire training area.*

Response: Comment noted. The two proposed wells downgradient of Site 11 have been removed from the sampling program. Therefore, no changes to the proposed drilling method are warranted at this time.

Specific Comment 9: Worksheet 17, Section 17.3 Groundwater: *At the time of sample collection a round of water levels needs to be incorporated if possible. Groundwater elevations at the time of sampling for the new flightline wells, with some combination of wells at Building 555, Hanger 4, and former Hanger 1 and Hanger 2, would support interpretation of potential flowpaths from the new wells.*

Response: The text will be updated to indicate that a synoptic water level measurement round will be conducted as part of the proposed sampling program. A separate investigation in the Eastern Flightline Area, which includes groundwater sampling for PFCs, is planned to occur around the same time as the proposed basewide groundwater PFC investigation. Water level measurements are planned as part of the Eastern Flightline investigation and will be used to supplement the basewide groundwater PFC investigation. Worksheets 14 and 17 in the SAP will be revised to indicate the collection of a synoptic water level measurement round.

Specific Comment 10: Table 10-1:

- **Hanger 6** – *If a fire training area were in use north of the hanger, where would the expended foam have been washed to under typical conditions? If the practice were to wash the small amounts of foam to the edge of pavement and to the storm drains potential releases may not have warranted a report. Please clarify where the training was conducted, MEDEP could only find one aerial photo possibly showing the training "plane" and it was parked on grass in 2006. Unless it is documented that nothing could have been washed to the edge of the training area a groundwater sample in this vicinity to evaluate the fire training area/Hanger 6 is warranted.*

Response: Based on an interview with former Deputy Fire Chief Dave Lewis, the fire training area north of Hangar 6 was located on the abandoned runway and the training activities occurred on pavement. Mr. Lewis indicated that the training exercises in this area only used water (i.e., no AFFF was used). Information provided by Mr. Lewis indicated that accidental releases of AFFF from the fire suppression system did occur at Hangar 6. The SAP will be revised to include this information as well as proposed sampling in the vicinity of Hangar 6.

- **Building 653** – *although the RCRA closure report identified only one spill it is unclear whether the system was ever tested, or whether AFFF would leave a visual residual. The closure report indicates that surface/storm water discharged to a drainage north of*

the tank farm. This should be considered for future data collection if the system would have been tested during operation of the base.

Response: Based on an interview with former Deputy Fire Chief Dave Lewis, accidental releases of AFFF from the fire suppression system did occur at Building 653. The SAP will be revised to include this information as well as proposed sampling in the vicinity of Building 653.

**NAVY RESPONSES TO
BRUNSWICK AREA CITIZENS FOR A SAFE ENVIRONMENT (BACSE)
COMMENTS DATED JULY 23, 2014
ON THE TIER II SAMPLING AND ANALYSIS PLAN,
PERFLUORINATED COMPOUNDS IN GROUNDWATER,
FORMER NAVAL AIR STATION, BRUNSWICK, MAINE
(MAY 6, 2014)**

The Navy's responses to BACSE comments on the Navy's Tier II SAP, Perfluorinated Compounds in Groundwater, Former NAS Brunswick, Maine are presented below. BACSE comments are presented first (in italics) followed by the Navy's responses.

BACSE General Comments

General Comment 1: *BACSE agrees with many of the comments made by the Maine Department of Environmental Protection (MEDEP) in a comment letter dated June 19, 2014. Of particular importance is the MEDEPs request that the Navy report the full standard list of Perfluorinated compounds (PFCs) in order to adequately characterize the contamination at the site and determining if it effectively treated with the GWETS.*

Response: At this time only PFOS and PFOA will be analyzed in groundwater samples. However, the SAP will be revised to include one round of sampling at the Groundwater Extraction Treatment System (GWETS) and analyzed for 16 PFCs. The proposed sampling will include an influent sample, a sample collected in the middle of the treatment process, and an effluent sample. The additional PFCs will be used to determine the effectiveness of the GWETS on treatment of various PFCs, not just PFOS and PFOA.

BACSE Specific Comments

Specific Comment 2: Section 11.4 Temporal Boundaries: *The study calls for only one round of groundwater samples to be collected in order to assess potential contamination and to establish background concentrations. BACSE recommends a minimum of two sample rounds be completed as part of this investigation, or at a minimum collecting confirmatory samples of all PFC detections. Two rounds of groundwater level measurements should also be collected coincident with each sampling round.*

Response: The proposed sampling program is to determine the presence/absence of PFOS and PFOA. Based on those results, additional sampling events may be performed, if warranted, to further evaluate the nature and extent of contamination and/or to confirm the presence or PFC detections. One round of synoptic water level measurements will be collected prior to purging and sampling of monitoring wells.

Specific Comment 3: Section 11.6 Sampling Strategy: *The text states that the sampling is "anticipated to occur in the late spring/early summer of 2014." Please provide an updated time frame for the sampling program.*

Response: This section will be updated to include the correct proposed field investigation time period, which is currently proposed to be in the fall 2014.

Specific Comment 4: Section 11.7 Obtaining the Data – Monitoring Well

Development: The text states that ". Monitoring wells will be developed until turbidity is equal to or less than 10 nephelometric turbidity units (NTU), if possible. If turbidity less than 10 NTUs is not possible, development will continue until turbidity readings are stable in accordance with SOP 3-13 Monitoring Well Development, or until 2 hours of well development has elapsed, whichever is sooner." BACSE recommends that all new and existing monitoring wells used in the sampling program be developed until the turbidity is 10 NTU or less. If a turbidity of 10 NTU or less is not achieved after 2 hours of monitoring well development, BACSE recommends that the well be replaced with a properly constructed monitoring well using an appropriately sized screen and sand pack.

Response: Obtaining a turbidity of 10 NTU or less is not required as the laboratory analysis for PFCs is not directly affected by turbidity.

Specific Comment 5: Worksheet #17, Section 17.3 Groundwater: BACSE concurs with MDEP that groundwater samples should be collected in vicinity of Landfill 1 and 3 and the FTA/Hanger 6 and analyzed for the full list of PFCs.

Response: Based on additional PFC data not previously incorporated into this SAP, as well as additional details on the use and historic releases of AFFF, the proposed sampling program has been revised. Sample collection in the vicinity of Landfill 1 and 3 as well as Hangar 6 are included as part of the new proposed sampling program.

**NAVY RESPONSES TO ADDITIONAL
STATE OF MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION (MEDEP)
COMMENTS DATED OCTOBER 3, 2014
ON THE REVISED DRAFT TIER II SAMPLING AND ANALYSIS PLAN,
PERFLUORINATED COMPOUNDS IN GROUNDWATER,
FORMER NAVAL AIR STATION, BRUNSWICK, MAINE
(SEPTEMBER 11, 2014)**

The Navy's responses to MEDEP comments on the Navy's revised Tier II SAP, Perfluorinated Compounds in Groundwater, Former NAS Brunswick, Maine are presented below. MEDEP comments are presented first (in italics) followed by the Navy's responses.

MEDEP General Comments

***General Comment 1:** MEDEP has revised its electronic data deliverable (EDD) format slightly and is now requiring the quality control data be submitted along with the sample data. The associated codes and template are at the MEDEP website <http://www.maine.gov/dep/maps-date/egad/index.html>. This information has already been sent to Maine certified labs that submit data to the Department. Please also submit the laboratory report associated with the data, either as an appendix on CD or as an electronic download when the EDD is submitted. This information will support review of the data validation and improve any comments on the sample analysis.*

Response: The revised EDD format will be reviewed and the submitted EDD will incorporate the recent MEDEP updates. The laboratory analytical reports will be included as an appendix on CD with the Investigation Summary Report.

***General Comment 2:** Although Worksheets 18, 19, and 20 discuss the sample naming convention, MEDEP requests that the new well locations also be given an identifier such as "MW-PFC-101" or something similar to differentiate from wells installed at other sites at the base.*

Response: The new well nomenclature will be "PFC-MW-01". Table 11-1 and Figure 11-1 will be updated accordingly.

***General Comment 3:** MEDEP will propose to collect approximately 3 split samples for analysis at a separate lab during this investigation if funding and schedules permit.*

Response: Comment noted.

***General Comment 4:** The choice of screen interval at the new wells near Building 653 should be driven by the lithology encountered and depth to water, the old wells may not have been screened appropriately.*

Response: Comment noted. Lithology will also be evaluated as part of the installation of the new wells.

MEDEP Specific Comments

Specific Comment 5: Worksheet 10, Section 10.4.4, Fire Suppression Systems: *The text in the second paragraph describing Building 81 is unclear. Is the system in place and transferred or was it removed prior to transfer?*

Response: The text will be updated to clarify that the fire suppression system in Building 81 was dismantled prior to the transfer of the property.

Specific Comment 6: Worksheet 14, Quality Control: *If well conditions dictate the use of bladder pumps at any of the wells, please assign one of the equipment blanks to this sample equipment.*

Response: Agreed. Should bladder pumps be used at any of the wells, equipment blanks will be collected from the sample equipment used.

Specific Comment 7: Worksheet 15: *Use of the MEDEP PFOA value of 0.1 ug/L is acceptable as a screening value for PFOS until a formal Maine maximum exposure guideline is released by MECDC.*

Response: No response necessary.

**NAVY RESPONSES TO
ENVIRONMENTAL PROTECTION AGENCY (EPA)
COMMENTS DATED OCTOBER 3, 2014
ON THE REVISED DRAFT TIER II SAMPLING AND ANALYSIS PLAN,
PERFLUORINATED COMPOUNDS IN GROUNDWATER,
FORMER NAVAL AIR STATION, BRUNSWICK, MAINE
(SEPTEMBER 11, 2014)**

The Navy's responses to EPA comments on the Navy's revised Draft Tier II SAP, Perfluorinated Compounds in Groundwater, Former NAS Brunswick, Maine are presented below. EPA comments are presented first (in italics) followed by the Navy's responses.

EPA General Comments

General Comment 1: *Influent, mid-treatment, & effluent samples are proposed for the E.Plume treatment system. EPA requests the following treatment process samples be collected:*

- a) plant influent*
- b) HiPOx effluent*
- c) Liquid GAC mid-point*
- d) plant effluent*

This data will be useful in fully assessing the relative PFC influent removal efficiencies of the HiPOx and GAC unit processes.

Response: The above proposed sample collection points will be collected as part of the proposed GWETS sampling program. The SAP will be updated accordingly.

General Comment 2: *All wells sampled for PFCs by TetraTech and Resolution should follow strict PFC-cross contamination SOPs. Typically, peristaltic pumps with silicone & HDPE tubing are suitable for shallow ground water PFC sampling (< 25' of depth) while submersible stainless steel pumps with PVC leads are suitable for ground water depths greater than 25' (the bladder material of bladder sample pumps are typically made of PFC-containing materials). If VOC samples are to be collected in addition to PFCs (i.e., TetraTech SAP), PFCs should be sampled first. For VOC sample collection, use of a peristaltic pump is not recommended.*

Response: It is anticipated that the majority of the monitoring wells will be sampled using peristaltic pumps as part of the proposed PFC investigation. However, several wells are expected to require submersible stainless steel pumps. Every effort will be made to limit the use of PFC-containing materials, although it is not expected that every potential PFC-containing material can be replaced with non-PFC-containing materials. Equipment blanks will be collected from bladder pump equipment used as part of the quality assurance process.

General Comment 3: *As ground water flow directions have not been accurately established for portions of the former base that will be targeted for PFC gw sampling, additional monitoring*

October 7, 2014

wells may need to be installed upon completion of this work should current gw flow direction assumptions be inaccurate.

Response: Agreed.